ARPA ORDER NO. 189-1

MEMORANDUM
RM-5550-ARPA
MAY 1968

REAL TIME RECOGNITION OF HANDPRINTED TEXT: PROGRAM DOCUMENTATION

G. F. Groner

PREPARED FOR:
ADVANCED RESEARCH PROJECTS AGENCY

The RAND Corporation
SANTA MONICA • CALIFORNIA

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PREFACE

This Memorandum documents a computer program for the recognition of symbols handprinted on a RAND Tablet or similar device used in conjunction with a CRT display. This documentation describes the program in sufficient detail to facilitate its use, maintenance, and/or recoding in another computer language. Since the program is written in IBM-360 assembly language, understanding of the documentation requires familiarity with this language. The study resulting in this program is but one facet of an overall search for techniques to increase the facility of the man-computer interface.

SUMMARY

This Memorandum documents a computer program that permits an on-line computer user to print text naturally and have it recognized accurately. The program recognizes handprinted letters, numbers, punctuation marks, and geometric figures; it separates characters written in quick succession and in close proximity. The program is written as a re-entrant process in IBM-360 assembly language; it requires about thirty-seven hundred 32-bit words of storage. The user must provide programs that 1) communicate with an input device such as the RAND Tablet to supply a sequence of writing-instrument coordinates to the recognition program; 2) select options in real-time based on context; and 3) use the recognition program's outputs for displaying and editing information on a CRT display device.

This documentation describes the program at two levels. The most general description lists the symbols recognized and discusses feature extraction, character separation, symbol recognition, and user options. The second level provides a computer listing of the assembly-language program. This listing includes descriptions of the logical functions, calling sequences, and input/output parameters of each of the major processes comprising the program, and outlines the information processing and flow of control. The Appendix briefly describes processes and macros that perform functions required by the recognition program.

CONTENTS

I. INTRODUCTION

This Memorandum documents a symbol-recognition program[†] that is part of an experimental software system called GRAIL (GRAphical Input Language) [2] under development at The RAND Corporation (and supported by the Advanced Research Projects Agency). The objective of GRAIL is to investigate methods by which a user may deal directly, naturally, and easily with his problem. As one means of eliminating distracting operational mechanics from problem solving, the system features the ability to communicate with a computer via a single pen-like instrument moved over a two-dimensional surface in conjunction with a *CRT display*.[††] Communication is enhanced by incorporating a program that interprets freehand motions and provides immediate feedback.[†††]

This *symbol*-recognition program allows an on-line computer user to print or draw symbols naturally, and have them recognized accurately and quickly, even though it recognizes a large set of symbols. Designed to work for many users, the program imposes few constraints on style, speed, or position of writing; it is not intended to be modified for individual printing styles. It makes use of size and position information to differentiate among symbols not distinguishable by shape alone. Preliminary experiments [1] indicate that recognition accuracy (not including lower-case letters and geometric symbols) is about 90 percent for inexperienced

[†] A general description of this program together with a discussion of user interaction, a performance evaluation, and references to related work appear in Ref. 1.

[††] Italicized words are defined in the Glossary at the end of this section (pp. 5-10).

[†††] An immediate, continuous track on the display corresponds to the writing instrument position. A completed track is replaced by a symbol after a few milliseconds for recognition plus a time delay for symbol separation.

users. This error rate is tolerable because of the quick response and the GRAIL editing facilities.

The recognition program has been used daily, as part of the GRAIL system, while developing means for creating, editing, and executing computer code and flowcharts. The GRAIL system is being developed on an IBM System/360 Model 40 and is written in 360 assembly language.

The recognition program within the GRAIL system is written to operate under a nonstandard GRAIL supervisor and in conjunction with a nonstandard CRT display; a modified version has been written that operates under the IBM OS/360 operating system and in conjunction with an IBM 2250 display unit. The differences between the GRAIL recognition program documented here and the OS program are summarized in the Appendix. The OS program also has a number of users at RAND (its use is described in Ref. 3).

THE PROGRAM

The user must provide programs that: 1) communicate with an input device such as the RAND Tablet [4] in order to provide a sequence of x,y coordinates to the recognition program; 2) select options in real-time based on the context of the input; and 3) use the recognition program's outputs for displaying and editing information on a CRT display based on context. When the recognition program has been provided with a time-ordered set of x,y coordinates (describing the motion of a writing *stylus*) and a set of control bits, it normally places *vector* strings (which approximate the stylus motion) directly into a display *buffer* as it receives the inputs; upon completion of each symbol, the program returns a *character code* (its interpretation of the input) along with some geometrical properties of the symbol.

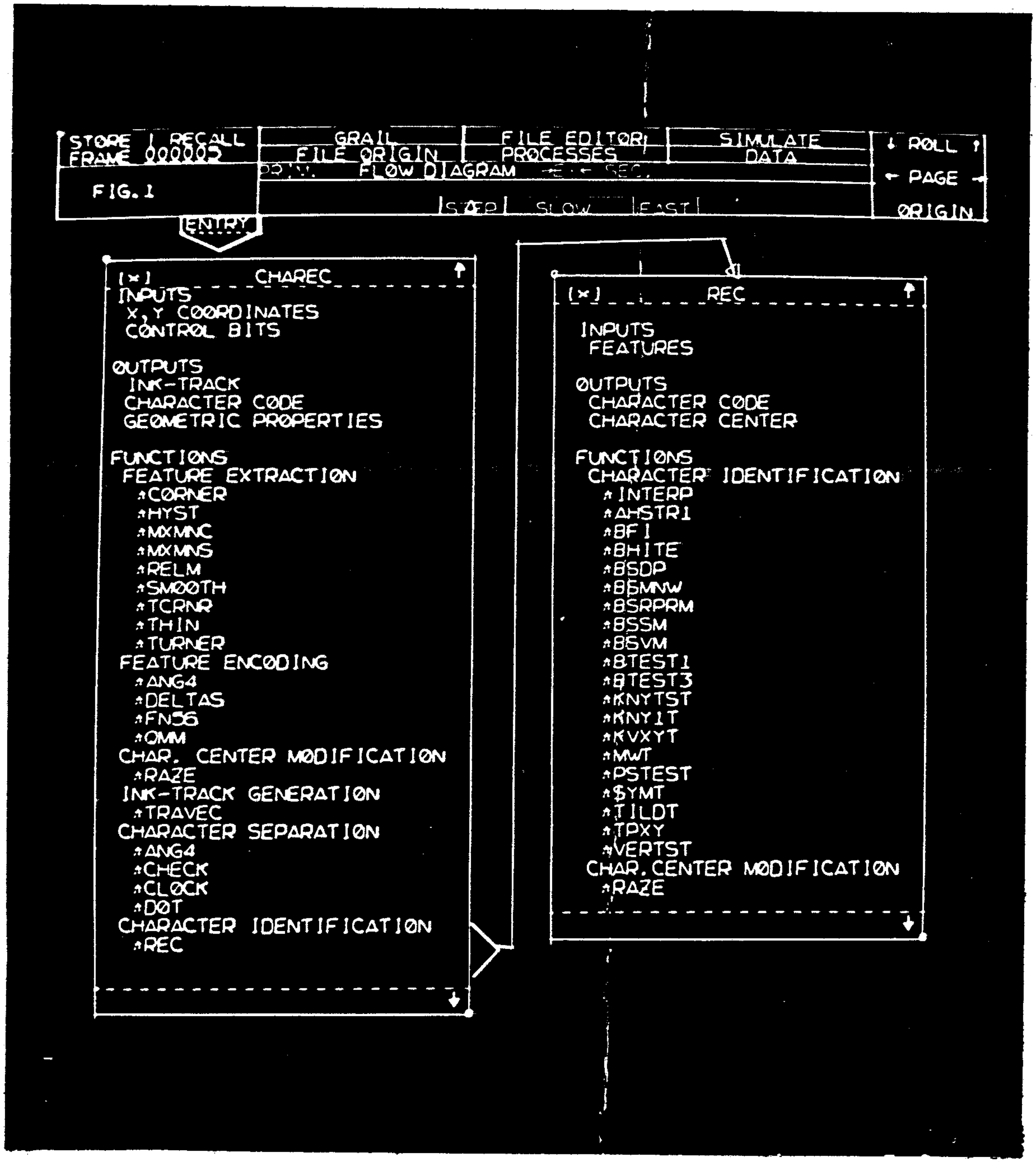
The recognition program is written as a *reentrant process* in 360 assembly language. It requires about thirty-seven hundred 32-bit words of storage. Each logical *instance* of this *process* requires 26 words for *data* and *context;* the remaining storage is for the *read-only* code, which is required only once.

The user program *calls* the process CHAREC, which in turn calls the processes REC and CLOCK and a set of *remote code sequences* (processes with general-purpose register input/output operating in the environment of the calling process context) referred to herein as *RCS*'s. CHAREC and its RCS's perform "inking" (generation of the vector strings), *feature* extraction, and character separation. CLOCK is used as a real-time clock for separating characters by timing. REC, together with its RCS's, identifies characters by testing the features computed by CHAREC. Most of the tests are performed in INTERP, an RCS comprised of decision tables. Figure 1 outlines the input/output parameters and logical functions of the two processes CHAREC and REC. The processes and RCS's called by CHAREC and REC are indicated by asterisks. The figure was drawn using the GRAIL system (but does not illustrate this system's scope or symbology).

THE DOCUMENTATION

The following documentation describes the program at two levels. The most general description lists the symbols recognized and discusses feature extraction, character separation, character identification, and user options.

The second level provides a computer listing of the assembly-language program. This listing includes descriptions of the logical functions, *calling sequences*, and input/output *parameters* of each of the processes and RCS's (except CLOCK); and outlines the sequence of information processing in CHAREC, REC, and INTERP. *Entry points* in these outlines are labeled (e.g., ****ENTRY****) identically to the corresponding entry points in assembly-language program listings. Also described are the program's parameters, features, and indicators used by CHAREC, REC, and the RCS's.



```
(×)          CHAREC
INPUTS
 X,Y CØØRDINATES
 CØNTRØL BITS

ØUTPUTS
 INK-TRACK
 CHARACTER CØDE
 GEØMETRIC PRØPERTIES

FUNCTIØNS
 FEATURE EXTRACTIØN
  *CØRNER
  *HYST
  *MXMNC
  *MXMNS
  *RELM
  *SMØØTH
  *TCRNR
  *THIN
  *TURNER
 FEATURE ENCØDING
  *ANG4
  *DELTAS
  *FN56
  *QMM
 CHAR. CENTER MØDIFICATIØN
  *RAZE
 INK-TRACK GENERATIØN
  *TRAVEC
 CHARACTER SEPARATIØN
  *ANG4
  *CHECK
  *CLØCK
  *DØT
 CHARACTER IDENTIFICATIØN
  *REC
```

```
(×)          REC

INPUTS
 FEATURES

ØUTPUTS
 CHARACTER CØDE
 CHARACTER CENTER

FUNCTIØNS
 CHARACTER IDENTIFICATIØN
  *INTERP
  *AHSTR1
  *BFI
  *BHITE
  *BSDP
  *B$MNW
  *BSRPRM
  *BSSM
  *BSVM
  *BTEST1
  *BTEST3
  *KNYTST
  *KNY1T
  *KVXYT
  *MWT
  *PSTEST
  *$YMT
  *TILDT
  *TPXY
  *VERTST
 CHAR.CENTER MØDIFICATIØN
  *RAZE
```

Fig. 1—CHAREC and REC outlines

In addition to summarizing the difference between the GRAIL and OS programs, the Appendix lists the CRT display character codes and briefly describes CLOCK, CHAR (the GRAIL process that allows the user's application program to interact with the Tablet by providing a convenient interface), and the GRAIL macros as used by the recognition program.

GLOSSARY[†]

A(NAME)	The address of NAME.
ANAME	In a *call* to *process* NAME, this is a linkage between the calling process *context* and NAME's context; the label "ANAME" is user determined.
aspect ratio	A *character's* height divided by its width.
buffer	A number of *bytes* used for transmitting *x,y* coordinates to the recognition program or *vector* strings from the program.
byte	Eight bits; referred to as 0 to 7, left to right.
call	Transfer of flow of control to another *process*.
calling sequence	The sequence of information and commands required to *call* a *process*.
cannot interpret	A sequence of input coordinates not interpretable as one of the allowable *symbols*; same as "*no character*."
CRT	Cathode ray tube.

[†] In addition to those italicized above, other words and phrases used throughout the text are also defined.

character
A sequence of input coordinates encoded as an entity by this program; same as "*symbol*" (see The Symbols Recognized, Sec. II).

character code
A 1-*byte* encoding of a *character* (see CRT Display Character Codes, Appendix, p. 162).

context
1) a continuous storage block consisting of linkages between *parent* (*calling*) and *daughter* (*called*) *processes*, *formal parameters*, and other information; 2) the environment used to interpret the meaning of an action or inputs.

data
1) *x*,*y* coordinates; 2) indicators or computed quantities used by the program.

daughter process
A *process called* by a *parent process*.

display
A programmed output device that presents an image.

display stream
The sequence of instructions controlling the *display*.

EEXIT
Appears in a *call* to a *process* or RCS; EXIT is a re-entry point in the calling (*parent*) process corresponding to a return from the called (*daughter*) process or RCS; the label "EXIT" is user determined.

ending point
The *x*,*y* position at which the writing *stylus* micro switch is opened when terminating a *stroke*.

entry point
The place at which control resumes.

F

1) full computer word (32 bits);
2) *formal* (input/output) *parameter*.

feature

A computed attribute of a *symbol* which is used for identification.

formal parameter

An input/output *data* location provided a *process* by its *parent*.

FPARAM

In a *call* to a *process*, refers to the *formal* (input/output) *parameter* PARAM of the calling (*parent*) process; the label "PARAM" is user determined.

geometric corner

A detected sharp change (90° or more) in the direction of the writing *stylus* motion.

GPARAM

A reference to the *parameter* PARAM in a *call* to a *process*. G = F for a *formal* (input or output) parameter of the calling process; G = I for an *informal* (local) parameter; the label "PARAM" is user determined.

H

Computer halfword (16 bits).

informal parameter

Temporary or constant *data* defined within a *process*.

ink

1) same as "*ink track*"; 2) the action of generating an *ink track*.

ink track

A displayed string of *vectors* that approximates the writing *stylus* motion.

instance

The appearance of a *calling sequence* to a *process* in the program.

IPARAM

In a *call* to a *process*, refers to the *informal* (local) *parameter* PARAM of the calling (*parent*) process; the label "PARAM" is user determined.

NAMEA
In a *call* to *process* NAME, a read-only link to NAME; the label "NAMEA" is user determined.

no character
A sequence of input coordinates not interpretable as one of the allowable *symbols*; same as "*cannot interpret*."

parameter
Temporary or constant *data*.

parallel task
An instruction sequence initiating two lines of control within the program.

parent process
The *process* that *call*ed a *daughter process*.

pen
The writing instrument that is moved on the *Tablet* writing surface; same as "*stylus*."

pendown
Closure of the writing *stylus* micro switch due to a downward force.

penup
Opening of the writing *stylus* micro switch by release of a downward force.

PSG
Program Status Group, a GRAIL conceptual entity used for parallel task synchronization.

process
A computer program segment, somewhat akin to a subroutine, accessed by a formal call (see "*reentrant process*").

raster unit
1/1024 of the *Tablet* or *display* surface dimension--0.01 in. in the case of a standard 10.24 by 10.24-in. Tablet.

raw data point — A writing stylus coordinate pair as received from the input device.

read-only — Computer storage that is read (and executed if code) but not modified.

reentrant process — A *process* requiring separate linkage and data storage blocks for each usage, but only a single storage block of *read-only* code. When executed, the code is not modified and therefore may be re-used even if the process has been suspended before completion.

RCS — *Remote code sequence.*

remote code sequence — A process with general-purpose register input/output operating in the environment of the *calling* (*parent*) *process context*; has no context but is *reentrant*.

starting point — The *x*,*y* position at which the writing *stylus* micro switch is closed when initiating a *stroke*.

stroke — The sequence of *x*,*y* coordinates between closing and opening the writing *stylus* micro switch.

stylus — The writing instrument that is moved on the *tablet* writing surface; same as "*pen*."

subcharacter — A set of *x*,*y* coordinates encoded internally by the program, but which may not be a complete *character* and has not been outputted by the program.

symbol
A sequence of input coordinates encoded as an entity by this program; same as "*character*" (see The Symbols Recognized, in Sec. II).

tablet
An input device comprising a pen-like writing instrument and a writing surface [4]; as the *stylus* is moved over the surface its *x,y* coordinates are sent to the computer for processing.

task
A sequence of instructions initiating lines of control (see "*parallel task*").

time-pause corner
A detected deceleration-acceleration of the writing *stylus* motion.

track
1) same as "*ink track*"; 2) the action of generating an *ink track*.

vector
A line segment described by its length (2, 4, 6, or 8 *raster units*) and direction (1 of 16 in 22.5° increments).

x
The writing surface horizontal coordinate.

X (or any other non-blank character in column 72)
A continuation indicator.

y
The writing surface vertical coordinate.

II. GENERAL DESCRIPTION OF THE PROGRAM

THE SYMBOLS RECOGNIZED

Upper-case Latin alphabet.

Numbers: 0 through 9.

Lower-case (script) Latin alphabet: these characters are not recognized very accurately in the present program. A lower-case character output code may be changed to the corresponding upper-case output code by a one instruction change in CHAREC.

Punctuation marks: + - = / ( ) * $. , ' #

Left bracket, right bracket, less than, greater than, karat, tilda (tilda is not fully implemented--see TILDT, p. 155).

Geometric symbols (must be single stroke and larger in one dimension than twice the normally expected character height): Rectangle, circle, triangle (one side horizontal, the other two of approximately equal length), ellipse, diamond, trapezoid.

Erasure (scrubbing action).

Cannot interpret.

FEATURE EXTRACTION

The on-line nature of this program enables processing of the data point-by-point as the stylus is moved across the writing surface. In order to minimize time and storage requirements, therefore, CHAREC (together with its RCS's) extracts features as the data arrive. These features are:

The sequence of directions (right, left, up, or down) of stylus motion.

The number and relative (to character extents) positions of geometrically determined corners.

The number of pause-in-time determined corners.

The number and relative positions of relative maxima and minima in y (the vertical direction).

The number and relative positions of stroke starting and ending points.

The absolute size of the character in raster units (1 raster unit = 0.01 inch).

The ratio of height to width of the character.

The absolute position of the center of the character on the writing surface.

The first process in feature extraction is data reduction (thinning). When a data point arrives, its position is compared with that of the most recently accepted data point. It is accepted (used in further analysis) if these two points are sufficiently far apart; otherwise it is rejected. When this thinning distance is set to 0.02 in., data are reduced by a factor of about seven without losing any significant information about a 1/4-in.-high handprinted character. (The number of raw data points between thinned data points is required, however, for detecting pause-in-time corners.) Upon the acceptance of each new data point, tests are made for stylus direction, corners, and relative maxima and minima.

CHAREC is called into action when the stylus is placed on the writing surface (micro switch closed), and is notified (via an indicator) when it is lifted (micro switch opened). CHAREC is thus informed about the starting and ending of each stroke. When a stroke is completed, tests are made to determine if it is part of the same character as the previous stroke set (previous subcharacter). If so, the character extents are updated, the positions of various features are computed relative to these character extents, and this subcharacter is identified. Otherwise, the previous subcharacter is outputted as a character, this stroke treated as a new subcharacter, relative positions computed, and the stroke identified.

CHARACTER SEPARATION

CHAREC groups sets of strokes into characters by considering timing, and the geometric extents and identifications of the strokes. If a prespecified time elapses following the end of the most recent stroke, a character is considered completed regardless of what follows. This between-character time delay must be greater than the maximum expected delay between two strokes belonging to the same character--0.3 sec has proven optimum for experienced users. A set of strokes is considered to be a completed character if it cannot be combined with the following stroke to form an allowable character. Some stroke sets (e.g., those that form 8, Q, A, and E) cannot be combined with any other stroke to form an allowable character. Some other stroke sets (e.g., 0, 2, 3, T, and F) can be combined with some strokes but not with others. Strokes written in quick succession, which can be combined to form an allowable character, are tested for overlapping or adjacency--thus separating groups of strokes too far apart to form a character of the normally expected size.

CHARACTER IDENTIFICATION

REC (together with INTERP and RCS's) uses the set of features generated by CHAREC (and its RCS's) to decide what character was written. Individual strokes are identified, as they are drawn, via a data-dependent sequence of tests. The first test groups stroke descriptions according to the first four stylus directions. This test reduces the number of stroke possibilities--typically, to one or two. Any further test depends on the set of possible stroke identifications, and on previously tested features. The program thus has a tree structure as outlined in Fig. 2.

The recognition of a multiple-stroke symbol is based on the identities of the constituent strokes and on their relative positions--it is independent of stroke order. In most cases, each constituent stroke requires only a general, rather than a precise, identification (which is a code in P or PAD). For example, a stroke recognized as a 1,), (, or / if standing alone, need only be considered as a vertical (P=1) if part of a multiple-stroke symbol. This simplifies decision making.

REC performs a few simple tests, but mostly acts as a link between CHAREC and the testing procedures (INTERP and the RCS's), or between INTERP and the RCS's. INTERP performs sequences of tests on encoded 1-byte parameters, thereby including nearly all of the decision-making tree structure. Most of the RCS's perform complicated tests to discriminate among a particular set of characters.

The following comments may be useful when adding or deleting a character description. To add a description, write the character, observe its description (set of features calculated by CHAREC) either visually or in computer memory, and note the character code(s) outputted by the decision-making routines. If multiple characters are outputted, or if a single character with fewer strokes than the written character is outputted, then either this particular stroke combination is not allowed and must now be added to CHECK, or a new PAD code and a new PAD table (see INTERP, p. 116) entry must be added. If this problem does not occur, find the direction sequence (as encoded by ANG4) entry into INTERP; then follow through the tests, eventually reaching the test resulting in the outputted character. At this place, enter a feature test that will consistently distinguish between the written character and the outputted character. If no such feature (or set of features) exists,

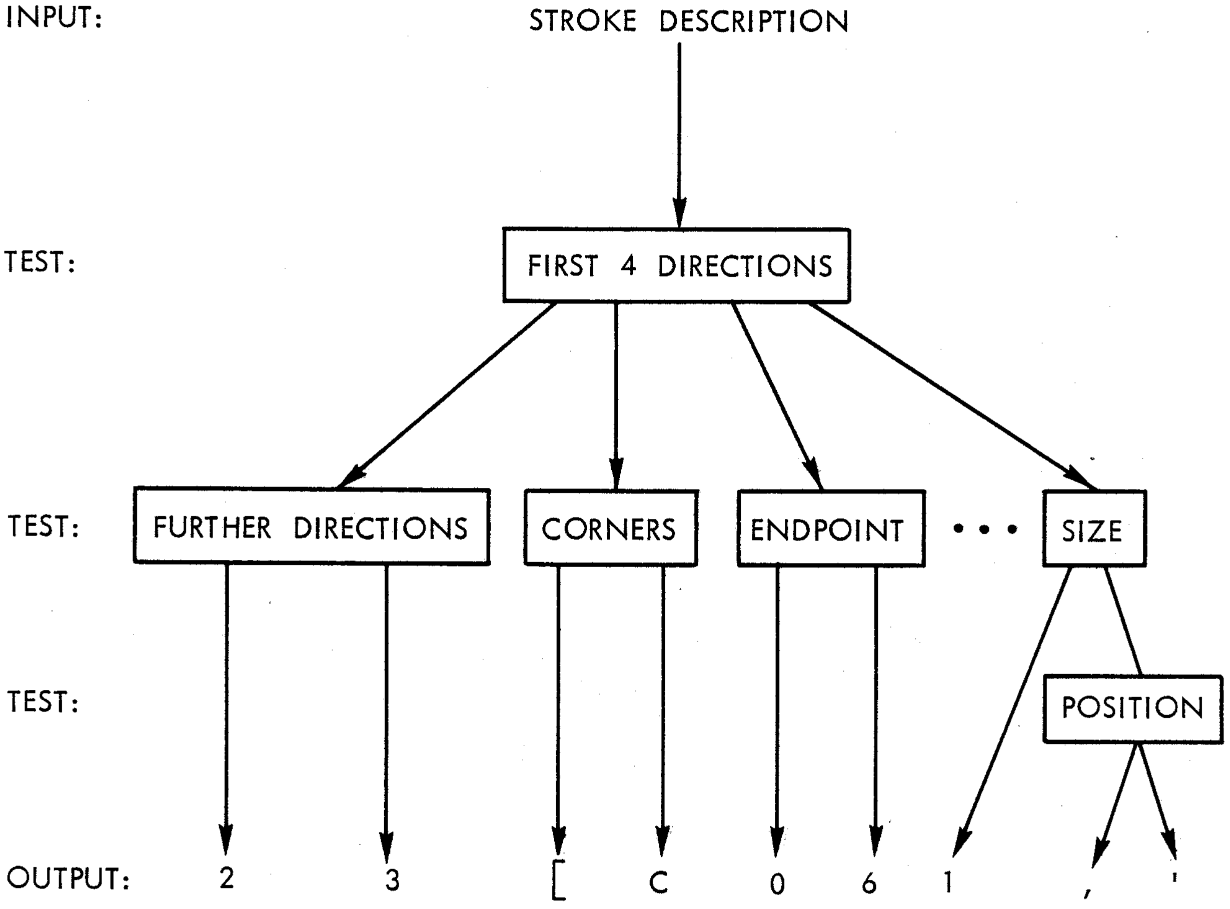


Fig.2—Outline of tree structure for character identification

it will be necessary to add a new CHAREC RCS to extract some new feature from the raw data. If this decision point occurs in the middle of a sequence of tests, it may be necessary to introduce a new PAD code and table entry. If strokes may be added to this character to generate new multi-stroke character descriptions, it must be added to CHECK. To delete a character description, follow through the tests as above, but delete the test(s) that result in this character. There may also be corresponding deletions from CHECK and the PAD codes and table entries.

A modification of the recognition program has been written that recognizes the mathematical symbols square root, infinity, integral, summation, and diagonal (upper-left to lower-right) in addition to the current symbols (except apostrophe and the geometric symbols). In order to allow any symbol to be written any size and at any position, the section of CHAREC that separates characters according to size and position (see CHAREC, p. 41) and the call (in REC, p. 93) to SYMT (which recognizes large single-stroke symbols as geometric symbols) were deleted. The tests for apostrophe were deleted from PSTEST so that a comma can be recognized when written in any position. The only new multi-stroke symbol--infinity comprised of the same strokes (2 0-like strokes) as a description of the number 8--did not require a change in CHECK or a new PAD code. The new symbols were added, however, to certain places in CHECK so that they can be combined with additional strokes to form multi-stroke symbols--e.g., if diagonal were not added to the vertical stroke section of CHECK, the letter x could not be written as a diagonal followed by a vertical. Since one of the first-4-direction descriptions (right-down-up-right) was previously a unique description (recognized as a script v), but could now also be a description of square root, a new code in ANG4 and a corresponding new entry into INTERP were added. All other changes--either feature tests or setting character codes--were made in INTERP. For example, a stroke with the direction sequence up-down-up--starting point not in the lower quarter of the stroke, and ending point in the lower half of the stroke--was recognized as the number 2; but now, in addition, it could be the symbol integral. At the place where these tests result in a branch to set the character code to 2 (see SNLC1 in INTERP, p. 111), this branch was replaced by a 2 versus integral test. This new test results in a branch to set character code to 2 if the stroke starting point is in the left half of the stroke; otherwise, it results in a branch to set character code to integral.

USER OPTIONS

Controls

CHAREC normally provides an ink track (constructed of vectors of user-specified length), and outputs character codes along with some character size and position information. The ink track for a handprinted character is deleted upon recognition of that character. The user may control the operation of CHAREC by specifying no-track and/or no-recognize, or halt with each group of data points (including during mid-stroke).

No-Track. CHAREC continues to process the data normally and recognize characters, but does not store an ink track. Any existing ink track is deleted.

No-Recognize. CHAREC continues to process the data normally and generate an ink track, but waits for more data when it would usually (with the recognize option) take a character or no-character (cannot interpret) exit.

Halt. CHAREC deletes any existing ink track and takes the halt exit. This allows the user to ignore the character recognizer when taking a control action not involving printing.

Vector Length

The user specifies the vector length to be 2, 4, 6, or 8 raster units, where 1 raster unit = 0.01 in. CHAREC generates (and stores in an ink buffer) a string of vectors of this length to approximate the raw data-point track--this is the ink track. The thinning distance used for data reduction is set equal to the vector length. If the vector length is 8 raster units, the between-character time delay is set to zero. The vector codes generated by CHAREC are for a particular CRT display and are not generally compatible with other displays.

Character Size

The user specifies the normally expected character height and width. This information is used for distinguishing between large and small symbols (e.g., geometric symbol versus not-geometric,) versus ', upper-case c versus lower-case c, etc.), and for character separation. Character separation by position is based on the distance (relative to the normally expected character width) between strokes, and on the positions of strokes within character spaces. Comma and apostrophe are distinguished by the position of the stroke within a character space. CHAREC assumes that the writing surface is divided into a grid of character spaces the size of a normal character. Each such character space's left (or bottom) edge is an integer number of character widths (or heights) from the writing surface's left (or bottom) edge.

Between-Character Time Delay

The user cannot set this delay which is used for separating characters. It is presently a CHAREC parameter (see CHAREC Read-Only Constants, p. 24). However, this time should become a user option by adding it to the list of

CHAREC inputs and changing CHAREC accordingly. This change does not alter the call for CHAREC, but does alter the parent routine's block of data for CHAREC.

III. FUNCTIONAL AND PROCEDURAL DESCRIPTIONS OF THE PROCESSES AND RCS'S

CHAREC

CHAREC Function

```
*CHAREC IS GIVEN THE TIME-SEQUENCE OF PEN-DOWNS, STYLUS COORDINATES,
* AND PEN-UPS.  IT PERFORMS THREE PRIMARY FUNCTIONS.
*
*1. GENERATE A VECTOR-INK TRACK (SPECIFIED VECTOR SIZE).
*
*2. CALCULATE A SET OF FEATURES FROM THE STYLUS COORDINATE SEQUENCE.
*   THESE FEATURES ARE PRESENTED TO THE ROUTINE 'REC' EACH TIME A
*   STROKE IS COMPLETED, AND 'REC' TRANSLATES THEM INTO A SUBCHARACTER
*   CODE.
*   THE FEATURES ARE:
*     FOR THE CURRENT STROKE
*        STYLUS DIRECTION SEQUENCE (QUANTIZED TO EAST, NORTH, WEST,
*         SOUTH FOR CHARACTERS.  QUANTIZED TO 16 DIRECTIONS FOR INK AND
*         GEOMETRIC FIGURES).
*        THE NO. AND POSITION OF GEOMETRIC CORNERS.
*        THE NO. OF TIME-PAUSE CORNERS.
*        THE NO. AND POSITIONS OF RELATIVE MAXIMA AND MINIMA IN Y.
*     FOR EACH STROKE
*        THE POSITIONS OF THE PENDOWN(STARTING) AND PENUP(ENDING) PTS.
*     FOR THE CHARACTER
*        THE BOUNDS
*        THE NO. OF STROKES.
*   QUANTIZATION OF DIRECTIONS TO 1 OF 4 PREVENTS THE GENERATION OF
*   TOO MANY DESCRIPTIONS OF THE SAME CHARACTER WHILE, WITH THE OTHER
*   FEATURES, IS SUFFICIENT FOR DISCRIMINATION.
*   MOST FEATURES ARE REPRESENTED AS 1-BYTE NUMBERS TO EASE TESTING.
*   FEATURE POSITIONS ARE INDEPENDENT OF WHERE THE CHARACTER IS DRAWN
*   ON THE TABLET BECAUSE THEY ARE CALCULATED RELATIVE TO CHARACTER
*   BOUNDS.
*
```

```
*3. DETERMINE WHEN A CHARACTER IS COMPLETE AND SEND THE CURRENT SUB-
*   CHARACTER CODE (ALONG WITH SOME GEOMETRIC INFORMATION--SEE OUTPUTS
*   LIST) TO THE USER.
*
*CHAREC HAS NO INK-TRACK, NO RECOGNIZE, HALT, AND SUPPRESS TABLET
*OPTIONS.  NO TRACK, AND NO RECOGNIZE ARE INDEPENDENT.
```

CHAREC Call

```
*        INST  ACHRC,CHRCA,GDATA,GCHPSG,GINDEX,EFINX,ENCHARX,ECHARX,EXTX
*              TN,EXTC
*
*WHERE ALL THE LABELS ARE SELECTED BY THE USER
* ACHRC IS A LINKAGE BETWEEN THE CALLING PROCESS CONTEXT AND CHAREC'S
*   CONTEXT
* CHRCA IS A LINK TO CHAREC
* DATA IS THE ADDRESS OF THE INPUTS-OUTPUTS DATA BANK (SEE 'CHAREC
*   INPUTS, OUTPUTS')
* CHPSG IS CHAREC'S PSG, 3F
* INDEX IS THE DATA/TIME EXPIRATION INDEX (0 = DATA, 1 = TIME), 1F
* EXITS FINX, NCHARX, CHARX, XTN, XTC ARE DESCRIBED UNDER 'CHAREC
*   EXITS'
```

CHAREC Inputs

```
*ICP     A(INK CCW), NO. OF BYTES DISPLAYED IS IN POSITION 6
*MCH     A(MATCH DATA), NOT USED
*KEYB    A(KEYBOARD DATA), EQU MCH, NOT USED
*PENU    A(PEN UP DATA), EQU MCH, NOT USED
*INPB    A(INPUT BUFFER), TIME SEQUENCE OF 12-BIT X, 12-BIT Y
*        WHEN EACH IS 10-BIT NO. OF RASTER UNITS, THEN THE 2 LEAST SIG-
*        NIFICANT BITS ARE 00.  THE NO. OF COORDINATE PAIRS IS VARIABLE
*        IT IS GIVEN IN 'INPL'.
*INKB    A(INK BUFFER), INK DESCRIPTION IS PLACED HERE WITH BYTE SEQ-
*        UENCE 00,LX,X,LYJ,Y,4S,V1,V2,V3,...,00 WHERE EACH SYMBOL
*        BETWEEN COMMAS IS 1 BYTE, (LX,X) IS LOAD X, (LYJ,Y) IS LOAD Y
*        AND JUMP TO NEW (X,Y), 4S IS ENTER VECTOR MODE WITH VECTOR
*        LENGTH CODE S (SEE 'IND') AND THE VI'S ARE VECTOR DIRECTION
*        CODES.
*INPL    INPUT BUFFER LENGTH, THE NUMBER OF STYLUS COORDINATE PAIRS
*        A GROUP OF 7 DATA POINTS ARRIVING IN 30 MS HAS BEEN FOUND CON-
*        VENIENT.  HALF WORD
*INKL    INK BUFFER LENGTH, THE MAXIMUM ALLOWABLE NO. OF BYTES IN THE
*        INK DESCRIPTION
*        HALF WORD
*IND     INDICATORS.  A 1 IN THE FOLLOWING BIT POSITIONS INDICATES POS-
*        ITIVE ACTIONS. 0=TRACK, 1=RECOGNIZE, 2=PENUP, 3=HALT, 4 AND 5=
*         CCDE FOR SIZE OF INK VECTORS (00=2 RASTERS, 01=4 RASTERS, 10=6
*         RASTERS, 11=8 RASTERS), 6, 7=NCT ASSIGNED
*BOX      EXPECTED CHARACTER WIDTH,HEIGHT: 12-BIT DX, 12-BIT DY
*         WHEN EACH IS 10-BIT NO. OF RASTER UNITS, THEN THE 2 LEAST SIG-
*         NIFICANT BITS ARE 0C.
```

CHAREC Outputs (Set in CHAREC or REC)

```
*EP       ENDPOINTS, THE PEN DOWN AND PEN UP LOCATIONS OF THE FIRST
*         STROKE IN THE CHARACTER. 12-BIT X, 12-BIT Y, 12-BIT X, 12-BIT
*         Y. (END OF CHAREC)
*CET      GEOMETRIC CENTER OF THE CHARACTER: 12-BIT X, 12-BIT Y
*         (END OF CHAREC)
*SIZE     ACTUAL CHARACTER WIDTH , HEIGHT: 12-BIT DX, 12-BIT DY
*         (END OF CHAREC)
*CHARA    CHARACTER CODE--SEE 'RAND CHARACTER CODES' (REC OR CHAREC)
*AR       1-BYTE NC. OF GEOMETRIC CORNERS, 1-BYTE ASPECT RATIC =
*         4 HEIGHT/WIDTH. (END OF CHAREC)
```

CHAREC Exits

```
*FINX     HALT EXIT
*NCHARX   NO CHARACTER EXIT, MORE DATA PENDING (PARALLEL TASK)
*CHARX    CHARACTER EXIT, MORE DATA PENDING (PARALLEL TASK)
*XTN      TERMINAL NO CHAR EXIT, NO MORE DATA
*XTC      TERMINAL CHAR EXIT, NO MORE DATA
```

CHAREC Parameters

```
*EACH X OR Y COORDINATE IS A 12-BIT NO. RIGHT JUSTIFIED IN A HALF-WORD
*
*ALL PARAMETERS ARE REFERENCED IN CHAREC.  OTHER REFERENCES ARE GIVEN
*IN PARENTHESES.  (REC) REFERS TO A REFERENCE IN ANY REC RCS (EXCEPT
*INTERP) IN ACDITION TO REC ITSELF.  (ANGLE) REFERS TO THE IN-LINE CODE
*SECTION OF CHAREC CALLED ANGLE.
*
*
*I1       TOP OF CATA BANK, ALSO TRANSLATICN OF 'CODE' (ANG4,CHECK)
*PAD      CONTAINS THE ACCRESS OF A PLACE IN 'INTERP' (REC,INTERP)
*CODE     SEQUENCE OF STYLUS CIRECTICNS--EACH 2 BITS IS A DIRECTICN
*         00=E, 01=N, 10=W, 11=S  (ANGLE,FN56,ANG4,REC,INTERP)
*XS,YS    X,Y COORDINATES CF A SMOOTHED DATA POINT
*XT,YT    X,Y COORDINATES OF A THINNED DATA POINT (MXMNS,RELM)
```

```
*DX,DY    X,Y DISTANCES BETWEEN 2 PTS IN A THINNED TRACK (RELM)
*MDX,MDY ABSOLUTE VALUES OF DX,DY
*PANG     CODE(SEE CODE) FOR PREVIOUS DIRECTION IN THE TRACK (ANGLE,
*         TURNER,RELM)
*PACANG   CODE (SEE CODE) FOR PREV. ACCEPTED DIRECTION. (ANGLE,TURNER)
*N        NO. DIRECTIONS IN THE LAST STROKE (ANGLE,FN56,ANG4,REC,INTERP)
*SN       TOTAL NO, OF STROKES (CHECK,DELTAS,REC,INTERP)
*PUP      CHAREC INDICATOR. BYTE 0 NOT USED.  1 IN THE FOLLOWING BIT
*         POSITIONS OF BYTE 1 INDICATE POSITIVE ACTIONS: 0,1=NOT USED
*         2=REQUEST FOR REC, 3=2 CHARACTERS, 4=PEN-UP-DELAY HAS HAPPENED
*         5=CLOCK HAS BEEN CALLED, 6=TAKE HALT EXIT, 7=NOT FIRST PENDOWN
*INKIND   NO. BYTES OF INK
*PQUAD    CODE(NE=00,NW=01,SW=10,SE=11) FOR QUADRANT OF PREVIOUS DIRECT-
*         ION (ANGLE)
*BR56     INDEX BASED ON DIRECTIONS 5 AND 6, VALUES 0-16 (FN56,INTERP)
*DXC,DYC X,Y EXTENTS OF CHARACTER (MXMNC,REC)
*XRC,XLC RIGHT,LEFT EXTREMES OF CHARACTER (DELTAS,MXMNC,REC)
*YTC,YBC TOP,BOTTOM EXTREMES OF CHAR. (DELTAS,QMM,MXMNC,BSRPRM,BHITE)
*ASPR     ASPECT RATIO = 4*DYC/DXC (INTERP)
*NT       NO. OF THINNED POINTS (TCRNR)
*NTC      NT AT WHICH LAST TIME-CORNER OCCURRED (TCRNR)
*INKC     NO. OF BYTES OF INK IN THE FIRST CHARACTER
*XYE,XYS CODED(SEE BELOW) SEQUENCE OF POSITIONS OF END,START POINTS OF
*         STROKES--1/2 WORD FOR EACH STROKE ENDPT,STARTPT.(DELTAS,REC,
*         INTERP)
*                             YTC
*                       3   2   1   0
*                XLC    7   6   5   4    XRC
*                      11  10   9   8
*                      15  14  13  12
*                             YBC
*WIDTH,HEIGHT  EXPECTED NORMAL CHARACTER WIDTH, HEIGHT--SEE BOX IN
*         INPUTS LIST (PSTEST)
*YCENT    Y COORDINATE OF CENTER OF PREVIOUSLY OUTPUTED CHARACTER
*PCHAR    CODE FOR PREVIOUSLY OUTPUTTED CHARACTER
*CUSP     TEMPORARY STORAGE (TCRNR,REC,INTERP)
*NCUSP    NO. GEOMETRIC CORNERS (INTERP)
*NPTS     NO. RAW DATA PTS. SINCE LAST THINNED PT. (TCRNR)
*DEL      MINIMUM X OR Y DISTANCE BETWEEN THINNED POINTS (DERIVED FROM
*         INC--SEE INPUTS). (RELM)
*P        CODE INDICATING TYPE OF PREVIOUS STROKE OR STROKES. 1=DOWN
*         VERT, 2=HORIZ, 3=7-LIKE, 4=V-LIKE, 5=C-LIKE, 6=O-LIKE, 7=U-
*         LIKE, 8=2 HORIZS., 9=UP VERT, 10=1 VERT AND 1 HORIZ, 11=2
*         VERTS. (REC,INTERP)
*CHAR     CHARACTER CODE(SEE CHARA IN LIST OF OUTPUTS) (REC,OCT,INTERP)
*TEMP     TEMPORARY STORAGE (REC,INTERP)
*TINK     NOT USED
*XSP,YSP X,Y COORDINATES OF SEQUENCE OF STARTING PTS. OF STROKES--1/2
*         WORD EACH (DELTAS,BSVM)
*XEP,YEP X,Y COORDINATES OF SEQUENCE OF ENDING PTS. OF STROKES--1/2
*         WORD EACH. (DELTAS,REC)
```

```
*ALXYJ   7 BYTES CONTAINING CO,LX,X,LYJ,Y,ENTER VECTOR MODE,00.  GOES
*        INTO INK BUFFER(SEE INKB IN LIST OF INPUTS)
*XL,YL   RAW DATA POINT COORDINATES
*XLO,YLO XL,YL USED BY TRAVEC (CORNER)
*AX,AX1,AX2,AX3  16-DIRECTIONS USED FOR GEOMETRIC CORNERS (CORNER)
*AX01,AX02,AX12,AX23
*        DIFFERENCES BETWEEN 16-DIRECTIONS (CORNER)
*NC      NO. GEOMETRIC CORNERS (CORNER)
*C       INTERNAL CORNER PARAMETER (CORNER)
*DYM     3/2 EXPECTED NORMAL CHARACTER HEIGHT--SEE BOX IN INPUTS LIST
*        (BHITE,PSTEST,TILDT)
*DXS,DYS X,Y EXTENTS OF CURRENT STROKE (MXMNS)
*XRS,XLS RIGHT,LEFT EXTREMES OF CURRENT STROKE (MXMNC,MXMNS)
*YTS,YBS TOP,BOTTOM EXTREMES OF CURRENT STROKE (MXMNC,MXMNS)
*CENT    X CENTER,Y CENTER--SEE CET IN OUTPUT LIST (RAZE,PSTEST)
*MVC     ADJUSTABLE MVC INSTRUCTION
*TTURN   CODE(SEE CODE) FOR A SINGLE DIRECTION TURN (TURNER)
*TURN    CODED(SEE CODE) SEQUENCE OF SINGLE DIRECTION TURNS (INTERP)
*XC,YC   SEQUENCE OF X,Y COORDINATES OF GEOMETRIC CORNERS (CORNER)
*        (XC=BSSM, YC=BSRPRM)
*DO THRU D15     NO. OF OCCURANCES OF DIRECTIONS 0 THRU 15 (SYMT)
*DN      SUM OF DO THRU D15 (SYMT)
*NTCUSP  NO. OF TIME CORNERS (TCRNR,REC,INTERP)
*PNPTS   PREVIOUS NPTS (TCRNR)
*PYMAX,PYMIN     Y LOCATION OF PREVIOUS RELATIVE Y MAX, MIN (RELM)
*NYMAX,NYMIN   NO. OF RELATIVE Y MAX,MIN (RELM,REC,INTERP)
*YMAX,YMIN     SEQUENCE OF Y LOCATIONS OF RELATIVE Y MAX,MIN FOR THE
*        CURRENT STROKE--1/2 WORD EACH (QMM,RELM,INTERP)
*QYMAX,QYMIN   SEQUENCE OF CODED(YTC,00,01,02,03,YBC) QUANTIZED YMAX,
*        YMIN--1  BYTE EACH (QMM,REC,INTERP)
*        ALSO USED AS AN INDICATOR(RELM)
*PYMXX,PYMNX   X LOCATION OF PREVIOUS RELATIVE Y MAX,MIN (RELM)
*YMAXX,YMINX   SEQUENCE OF X LOCATIONS OF RELATIVE Y MAX,MIN FOR THE
*        CURRENT STROKE--1/2 WORD EACH (RELM,INTERP,BSMNW,BTEST3)
```

CHAREC Read-Only Constants

```
*TIME    PEN-UP-DELAY TIME FOR CLOCK, F'0100' = 0.1 SECOND
*LXYJ    LOAD X, 00, LOAD AND JUMP TO Y ,00
*CDOT    THE CHARACTER CODE FOR A POINT
*HEX10   THE DECIMAL EQUIVALENT OF HEX 10
*HEX90   THE DECIMAL EQUIVALENT OF HEX 90
```

CHAREC Sequence of Information Processing

```
****START****
*
```

```
*GO TO NEW CHARACTER ENTRY , THEN CONTINUE
*
****NEW CHARACTER ENTRY****
*
*INITIALIZE
*RETURN
*
*
****NEW DATA POINT ENTRY****
*
*IF HALT DESIRED, GO TO FINISH ENTRY 1
*IF PEN UP, GO TO PEN UP SIGNAL ENTRY
*IF NOT FIRST PEN DOWN, GO TO MIDSTROKE NEW DATA POINT ENTRY
*
****NEW STROKE ENTRY****
*
*INITIALIZE
*SET NOT FIRST PEN DOWN INDICATOR
*SET UP STARTING POINT AND INK-VECTOR SIZE IN INK BUFFER
*SET UP THINNING DISTANCE
*IF INK DESIRED, SET DISPLAY COUNT
*
****MIDSTROKE NEW DATA POINT ENTRY****
*
*'THIN' DETERMINES IF THE CURRENT DATA PT. IS SUFFICIENTLY FAR FROM THE
* PREVIOUS THINNED PT.
*  NO, GO TO ANGLE SECTION-END
*'TCRNR' DETERMINES IF A TIME-PAUSE CORNER HAS OCCURRED
*CALCULATE INCREMENT BETWEEN NEW AND OLD THINNED POINTS
*'TRAVEC' CALCULATES 16-DIRECTION FOR INK
*IF NO INK-TRACK DESIRED, ZERO (SET TO 2) DISPLAYED INK COUNT, THEN
* SKIP TO 'CORNER' CALL
*STORE INK IF NEW THINNED PT. IS SUFFICIENTLY FAR FROM THE LAST PT. IN
* THE INK TRACK.
*'CORNER' DETERMINES IF A GEOMETRIC CORNER HAS OCCURRED AND CALCULATES
* ITS POSITION.
*'MXMNS' UPDATES STROKE BOUNDS
*'RELM' UPDATES RELATIVE MAXIMA AND MINIMA
*
****ANGLE SECTION-START****
*
*DETERMINE QUADRANT OF DIRECTION
*'HYST' MODIFIES DIRECTION FOR HYSTERESIS ZONE
*DETERMINE WHETHER EAST, NORTH, WEST, OR SOUTH
*IF NOT THE SAME AS THE PREVIOUS DIRECTION, 'TURNER' DETERMINES IF THIS
* WAS A 180 DEGREE TURN, THEN GO TO WAIT FOR NEXT DATA POINT
*IF THE SAME, PLACE IN DIRECTION SEQUENCE
*
****ANGLE SECTION-END****
*
*UPDATE THE DATA POINT COUNTER
```

```
*IF ALL DATA POINTS IN THE INPUT BUFFER HAVE NOT BEEN EXAMINED, GO TO
* MIDSTROKE NEW DATA POINT ENTRY
*OTHERWISE WAIT FOR NEXT DATA POINT GROUP
*
****WAIT FOR NEXT DATA POINT GROUP****
*
*(WAITING FOR A DATA POINT GROUP DOES NOT TIE UP THE CPU)
*WHEN NEW DATA POINT GROUP ARRIVES, THEN
*IF HALT DESIRED, GO TO FINISH ENTRY 3
*SET UP INK-VECTOR SIZE AND THINNING DISTANCE
*NEGATE REC REQUEST, 2 CHARACTERS, AND PEN-UP-DELAY INDICATORS
*GO TO NEW DATA POINT ENTRY
*
****PEN UP SIGNAL ENTRY****
*
*NEGATE NOT FIRST PENDOWN INDICATOR
*IF STROKE IS A DOT, 'DOT' CHECKS FOR POSSIBLE SCRIPT I OR J
*  IF YES, GO TO MULTI-STROKES ENTRY
*IF THIS IS THE ONLY STROKE, GO TO MULTI-STROKES ENTRY
*IF THE PREVIOUS SUBCHARACTER CANNOT BE COMBINED WITH ANY STROKE, GO TO
* THE MULTI-STROKES ENTRY
*'ANG4' AND 'CHECK' DETERMINE IF THE PREVIOUS SUBCHARACTER CAN BE
* COMBINED WITH THIS STROKE
*  IF NOT, GO TO THE MULTI-CHARACTERS ENTRY
*IF CURRENT STROKE IS A COMMA, GO TO MULTI-CHARACTERS ENTRY
*IF CURRENT STROKE  AND PREVIOUS SUBCHARACTER ARE NOT GEOMETRICALLY
* CLOSE ENOUGH TO BE COMBINED AS A CHARACTER, GO TO MULTI-CHARACTERS
* ENTRY.  (IF IT IS NOT DESIRED TO SEPARATE CHARACTERS BASED ON THEIR
* POSITIONS, REPLACE 'PTEST LA R7,1 WITH 'PTEST EQU *' AND DELETE ALL
* THE FOLLOWING CODE UP TO, BUT NOT INCLUDING, THE LINE LABELLED
* 'CASE1').
*
****MULTI-STROKES ENTRY****
*
*'MXMNC' UPDATES CHARACTER BOUNDS
*
****NEW CHARACTER PARAMETERS ENTRY****
*
*SET FIRST CHARACTERS INK COUNT TO TOTAL INK COUNT
*'DELTAS' QUANTIZES STARTING PT. AND ENDING PT. LOCATIONS
*'QMM' QUANTIZES RELATIVE Y MAX AND Y MIN LOCATIONS
*'ANG4' TRANSLATES FIRST 4 DIRECTIONS TO A 1-BYTE CODE CORRESPONDING TO
* A SET OF CHARACTERS
*'FN56' TRANSLATES DIRECTIONS 5 AND 6 TO A 4-BIT CODE
*COMPUTE ASPECT RATIO
*STORE NO. GEOM-CORNERS, AND NO. TIME-CORNERS
*COMPUTE CENTER
*IF NO. OF STROKES IS NOT 2, SKIP AROUND TESTS FOR SCRIPT I AND J
*IF PREV. SUBCHARACTER IS SCRIPT I, GO TO REC EXIT
*IF PREV. SUBCHARACTER IS SCRIPT J, 'RAZE' INCREASES Y CENTER
*IF NO. DIRECTIONS GTR 15, CHAR IS SCRUB, GO TO REC EXIT
```

```
*IF NO. DIRECTIONS NOT GTR 8 GO TO REC CALL
*IF NO. DIRECTIONS GTR 12, OR CHARACTER IS LARGE, SET CHAR=SCRUB, GO TO
* REC EXIT
*
****REC CALL****
*
*CALL REC, THEN GO TO REC EXIT
*
****MULTI-CHARACTERS ENTRY****
*
*IF FIRST CHARACTER INK COUNT=TOTAL INK COUNT, I.E. IF THERE IS ONLY 1
* CHARACTER PENDING, GO TO RESTORE INK COUNT ENTRY
*SET INK COUNT TO INK COUNT LESS FIRST CHARACTER INK COUNT, I.E. TO 2ND
* CHARACTER INK COUNT
*ZERO (SET TO 2) DISPLAYED INK COUNT, AND SAVE PREVIOUS DISPLAYED INK
* COUNT.
*MOVE 2ND CHARACTER INK TO THE HEAD OF THE INK BUFFER.
*IF NO TRACK DESIRED, GO TO ZERO INK COUNT ENTRY
* CHARACTER INK COUNT, I.E. TO 2ND CHARACTER INK COUNT.
*
****ZERO INK COUNT ENTRY****
*
*SET TOTAL INK COUNT TO ZERO
*
****DON'T RESTORE ENTRY****
*
*SET REC REQUEST AND 2 CHARACTERS INDICATORS
*
****2 CHARACTERS ENTRY****
*
*IF NO RECOGNITION IS DESIRED, GO TO WAIT FOR NEXT DATA POINT GROUP.
*IF CHARACTER IS NOT RECOGNIZABLE, GO TO NO CHARACTER ENTRY
*IF REC HAS NOT BEEN REQUESTED, GO TO TERMINAL CHARACTER ENTRY
*INTIATE PARALLEL PROCESS.  HIGH PRIORITY TAKES CHARACTER EXIT.  LOW
* PRIORITY GOES TO RESET FOR NEW CHARACTER ENTRY
*
****RESET FOR NEW CHARACTER ENTRY****
*
*RESET CHAR SIZE, STARTING AND ENDING POINT LOCATIONS, CENTER, ETC.
*GO TO NEW CHARACTER PARAMETERS ENTRY
*
****REC EXIT****
*
*IF NO. DIRECTIONS GTR 8, AND CHARACTER IS NOT SCRIPT, SET CHAR=SCRUB
*NEGATE REC REQUEST AND 2 CHARACTERS INDICATORS
*SET TIME/DATA EXPIRATION INDEX TO TIME
*IF DESIRED INK-VECTOR SIZE IS 8 RASTERS, GO TO CLOCK EXPIRED ENTRY
*SET CLOCK HAS BEEN CALLED INDICATOR
*CALL CLOCK,THEN GO TO CLOCK TURNED OFF OR CLOCK EXPIRED
*
****CLOCK EXPIRED (DUE TO RUNNING LONGER THAN 'TIME') ENTRY****
```

```
*
*TURN OFF CLOCK (SET)
*PAUSE, THEN GO TO CLOCK TURNED OFF ENTRY
*
****CLOCK TURNED OFF (DUE TO PENDOWN) ENTRY****
*
*IF HALT DESIRED, GO TO FINISH ENTRY 3
*NEGATE CLOCK CALLED INDICATOR
*IF TAKE FINISH EXIT INDICATOR IS SET, GO TO FINISH ENTRY 2
*GO TO SET UP OUTPUTS ENTRY, THEN RETURN HERE
*IF 2 CHARACTERS INDICATOR IS SET, GO TO 2 CHARACTERS ENTRY
*IF TIME/DATA EXPIRATION INDEX IS SET TO DATA, GO TO NEW DATA PT. ENTRY
*RESET ALL INTERNAL INDICATORS
*GO TO 2 CHARACTERS ENTRY
*
****FINISH ENTRY 1****
*
*IF CLOCK HAS BEEN CALLED, GO TO FINISH ENTRY 2
*SET TAKE FINISH EXIT INDICATOR
*GO TO CLOCK EXPIRED ENTRY
*
****SET UP OUTPUTS ENTRY****
*
*MOVE APPROPRIATE INTERNAL VALUES TO OUTPUTS
*RETURN
*
****NO CHARACTER ENTRY****
*
*IF REC HAS NOT BEEN REQUESTED, GO TO TERMINAL NO CHAR ENTRY
*INITIATE PARALLEL PROCESS.  HIGH PRIORITY TAKES NO CHAR EXIT.  LOW
* PRIORITY GOES TO RESET FOR NEW CHARACTER ENTRY
*
****FINISH ENTRY 2****
*
*GO TO SET UP OUTPUTS ENTRY, THEN RETURN HERE
*
****FINISH ENTRY 3****
*
*GO TO SET UP INK ENTRY, THEN RETURN HERE
*TAKE HALT EXIT
*
****TERMINAL CHARACTER ENTRY****
*
*GO TO SET UP INK ENTRY, THEN RETURN HERE
*TAKE TERMINAL CHARACTER EXIT
*
****TERMINAL NO CHAR ENTRY****
*
*GO TO SET UP INK ENTRY, THEN RETURN HERE
*TAKE TERMINAL NO CHAR EXIT
*
```

```
****SET UP INK ENTRY****
*
*IF DESIRED INK-VECTOR SIZE IS 8 RASTERS, RETURN
*ZERO (SET TO 2) DISPLAYED INK COUNT
*RETURN
*
****END OF CHAREC****
```

CHAREC Program Listing

```
         USING XR1,R1
         USING XR3,R3
         USING XR4,R4
         SVCS
         REGS
CD1      DSECT
XR1      DS    3F
AREC     DS    1F
CLK1     DS    1F
DATA     DS    1F
WAITBX   DS    1F
INDEX    DS    1F                       TIME/DATA EXPIRATION INDEX
FINX     EQU   0
NCHARX   EQU   4
CHARX    EQU   8
XTN      EQU   12                       TERMINAL NO CHAR EXIT
XTC      EQU   16                       TERMINAL CHAR EXIT
CD4      DSECT
XR4      DS    0F
ICP      DS    1F                       A(INK CCW)
MCH      DS    1F                       A(MATCH DATA)
KEYB     EQU   MCH                      A(KEYBOARD DATA)
PENU     EQU   MCH                      A(PEN UP DATA)
INPB     DS    1F                       A(INPUT BUFFER)
INKB     DS    1F                       A(INK BUFFER)
INPL     DS    1H                       INPUT BUFFER LENGTH
INKL     DS    1H                       INK BUFFER LENGTH
EP       DS    2F                       END POINTS
CET      DS    1F                       CENTER
SIZE     DS    1F                       ACTUAL CHARACTER SIZE
IND      DS    1C                       INDICATORS
CHARA    DS    1C                       CHARACTER
AR       DS    1H                       # CORNERS, ASPECT RATIO
BCX      DS    1F                       MAX CHARACTER SIZE
CD3      DSECT
XR3      DS    0F
I1       DS    1F
PAD      DS    1F
CODE     DS    1F
XS       DS    1H
YS       DS    1H
XT       DS    1H
```

```
YT        DS     1H
DX        DS     1H
DY        DS     1H
MDX       DS     1H
MDY       DS     1H
PANG      DS     1H
PACANG    DS     1H
N         DS     1H
SN        DS     1H
PUP       DS     1H
INKIND    DS     1H
PQUAD     DS     1H
BR56      DS     1H
DXC       DS     1H
DYC       DS     1H
XRC       DS     1H
XLC       DS     1H
YTC       DS     1H
YBC       DS     1H
ASPR      DS     1H
NT        DS     1H
NTC       DS     1H
INKC      DS     1H
XYE       DS     10C
XYS       DS     10C
WIDTH     DS     1H
HEIGHT    DS     1H
          DS     2F
YCENT     DS     1H
PCHAR     DS     1C
CUSP      DS     1C
NCUSP     DS     1H
NPTS      DS     1H
DEL       DS     1H
P         DS     1C
CHAR      DS     1C
TEMP      DS     1C
TINK      DS     5C
XSP       DS     10C
YSP       DS     10C
XEP       DS     10C
YEP       DS     10C
ALXYJ     DS     8C
XL        DS     1H
YL        DS     1H
XLO       DS     1H
YLO       DS     1H
AX3       DS     1H
AX2       DS     1H
AX1       DS     1H
AX        DS     1H
```

```
AX23      DS     1H
AX12      DS     1H
AX01      DS     1H
AX02      DS     1H
NC        DS     1H
C         DS     1H
DYM       DS     1H
DXS       DS     1H
DYS       DS     1H
XRS       DS     1H
XLS       DS     1H
YTS       DS     1H
YBS       DS     1H
CENT      DS     1F
MVC       DS     6C
TTURN     DS     1H
TURN      DS     1F
XC        DS     10C
YC        DS     10C
D0        DS     1H
D1        DS     1H
D2        DS     1H
D3        DS     1H
D4        DS     1H
D5        DS     1H
D6        DS     1H
D7        DS     1H
D8        DS     1H
D9        DS     1H
D10       DS     1H
D11       DS     1H
D12       DS     1H
D13       DS     1H
D14       DS     1H
D15       DS     1H
DN        DS     1H
NTCUSP    DS     1H
PNPTS     DS     1H
PYMAX     DS     1H
PYMIN     DS     1H
NYMAX     DS     1H
NYMIN     DS     1H
YMAX      DS     10H
YMIN      EQU    YMAX+10
QYMAX     DS     10C
QYMIN     EQU    QYMAX+5
PYMXX     DS     1H
PYMNX     DS     1H
YMAXX     DS     10H
YMINX     EQU    YMAXX+10
CHAREC    PROCS CLEAR=5,CNTX=9,AUTO=86,PROLG=XCHRX,ID=9000021F
```

```
TIME      DC    F'0300'
LXYJ      DC    X'54006000'
CDOT      DC    X'80'
HEX10     DC    F'16'
HEX90     DC    F'144'
MOVER     MVC   0(0,R6),0(R7)
ANG56     DC    V(FN56)
ANG4A     DC    V(ANG4)
DELT      DC    V(DELTAS)
RECA      DC    V(REC)
          DC    X'8000021C'
SMTH      DC    V(SMOOTH)
THINN     DC    V(THIN)
MAXMNS    DC    V(MXMNS)
HYSTR     DC    V(HYST)
CLK2      DC    V(CLOCK)
          DC    X'80000000'
MAXMNC    DC    V(MXMNC)
TRAVC     DC    V(TRAVEC)
CORNR     DC    V(CORNER)
TURNA     DC    V(TURNER)
CHECKA    DC    V(CHECK)
RELMA     DC    V(RELM)
QMMA      DC    V(QMM)
DOTA      DC    V(DOT)
TCRNRA    DC    V(TCRNR)
RAZEA     DC    V(RAZE)
XCHRX     PROLG
*
*
****START****
*
*
          CLEAR PSG=WAITBX,CNTX=F
          MVI   ALXYJ,X'00'
          MVI   ALXYJ+5,X'40'
          MVI   ALXYJ+6,X'00'
          MVC   MVC(6),MOVER
          BAL   R15,TOP
          B     WAITZ
*
*
****NEW CHARACTER ENTRY****
*
*
TOP       XC    I1(4),I1
          XC    PAD(4),PAD
          XC    SN(2),SN                # STROKES
          XC    INKIND(2),INKIND        INK INDEX
          XC    INKC(2),INKC
          XC    PUP(2),PUP
```

```
         XC     XRC(2),XRC
         XC     YTC(2),YTC
         XC     CHAR(1),CHAR
         XC     P(1),P
         XC     TTURN(2),TTURN
         XC     DO(32),DO
         XC     DN(2),DN
         LA     R6,1024
         SLL    R6,2
         STH    R6,XLC
         STH    R6,YBC
         L      R4,DATA                  STORE PREV CENT Y IN YCENT
         L      R7,CET
         STH    R7,YCENT
         L      R4,DATA                  STORE PREV CHAR IN PCHAR
         MVC    PCHAR(1),CHARA
         L      R4,DATA                  STORE MAX ALLOW DY IN DYM
         L      R7,BOX
         LR     R8,R7
         STH    R8,HEIGHT
         SRL    R8,16
         STH    R8,WIDTH
         LR     R8,R7
         SRL    R8,1
         AR     R7,R8                    1 1/2 CHARACTER HEIGHT
         STH    R7,DYM
         BR     R15
*
*
****NEW DATA POINT****
*
*
WAITZ    L      R4,DATA                  ENTRY FROM WAIT BOX
         TM     IND,X'10'
         BC     1,FIN                    B TO FIN IF HALT
         TM     IND,X'20'
         BC     1,IND2                   B TO IND2 IF P.U.
         LH     R12,INKIND               R12=INK BUFF IND
         TM     PUP+1,X'01'
         BC     1,PENDWN
*
*
****NEW STROKE****
*
*
         LH     R6,SN                    # STROKES OVERFLOW TEST
         LA     R8,5
         CR     R6,R8
         BC     4,SNLSS5
         SR     R6,R6
SNLSS5   LR     R8,R6
```

```
         SLL   R8,1
         LA    R6,1(R6)
         STH   R6,SN
*INITIALIZATION
         XC    NC(4),NC               INITIALIZATION
         LA    R6,16
         STH   R6,AX1
         STH   R6,AX
         MVC   AX3(4),AX1
         XC    NTCUSP(2),NTCUSP        # TIME CORNERS
         XC    NPTS(2),NPTS           # PTS BET. THIN PTS
         XC    NT(2),NT
         XC    NTC(2),NTC
         LA    R7,20
         STH   R7,PNPTS               PREV NPTS
         XC    NYMAX(2),NYMAX         # REL MAX
         XC    NYMIN(2),NYMIN         # REL MIN
         XC    N(2),N                 # ANGLES
         XC    C(2),C                 CORNER INDEX
         MVI   QYMAX,X'01'
         MVI   QYMIN,X'01'
         LA    R6,4
         STH   R6,PANG                PREV ANG =4
         STH   R6,PACANG              PREV ACC ANG =4
         STH   R6,PQUAD               PREV QUADRANT =4
         XC    XRS(2),XRS
         XC    YTS(2),YTS
         LA    R6,1024
         SLL   R6,2
         STH   R6,XLS
         STH   R6,YBS
         OI    PUP+1,X'01'
         L     R4,DATA
         L     R10,INPB
         LH    R7,0(R10)              1ST XRAW
         STH   R7,XS                  1ST SMOOTH X
         STH   R7,XT                  1ST X THIN
         STH   R7,XSP(R8)             X STARTING POINT
         STH   R7,XL
         STH   R7,PYMXX               X OF POT. YMAX
         STH   R7,PYMNX               X OF POT YMIN
         LH    R7,2(R10)              1ST Y RAW
         STH   R7,YS                  1ST Y SMOOTH
         STH   R7,YT                  1ST Y THIN
         STH   R7,YSP(R8)             Y STARTING POINT
         STH   R7,YL
         STH   R7,PYMAX               POTENTIAL Y MAX
         STH   R7,PYMIN               POTENTIAL Y MIN
         LA    R13,4
         B     REBUFF
CLNBUF   L     R4,DATA
```

```
         L     R7,ICP
         LA    R8,2
         STH   R8,6(R7)
REBUFF   L     R4,DATA
         LH    R15,INKL
         LA    R6,7(R12)
         CR    R6,R15
         BC    4,INKLOK
         SR    R12,R12
         B     CLNBUF
INKLOK   LH    R6,XL
         SRL   R6,2
         LH    R7,YL
         SRL   R7,2
         SLL   R6,16
         OR    R6,R7
         C     R6,LXYJ
         ST    R6,TEMP
         MVC   ALXYJ+1(4),TEMP
         L     R4,DATA                 SET VECTOR SIZE
         IC    R15,IND
         LA    R14,12
         NR    R15,R14
         LA    R14,64
         LR    R6,R15                  SET DEL, MIN THIN DIFF
         LA    R6,4(R6)
         SLL   R6,1
         STH   R6,DEL
         OR    R15,R14
         STC   R15,ALXYJ+5
         L     R15,INKB
         LA    R15,0(R12,R15)
         MVC   0(7,R15),ALXYJ
         SR    R6,R6
         STC   R6,7(R15)
         L     R4,DATA
*TEST FOR NO INKING
         TM    IND,X'80'
         BC    8,ENTER1
         L     R7,ICP
         LH    R15,6(R7)
         LA    R15,6(R15)
         LA    R12,6(R12)
         LA    R6,2(R12)
         CR    R15,R6
         BC    2,R15GTR
         LA    R15,1(R15)
R15GTR   STH   R15,6(R7)
         B     ENTER
*
*
```

```
****MIDSTRCKE NEW DATA POINT****
*
*
PENCWN   SR    R13,R13
ENTER    SR    R6,R6                   SMOOTH TRACK
         CR    R12,R6
         BC    8,CLNBUF
ENTER1   L     R4,DATA
         L     R10,INPB
         LH    R6,0(R13,R10)
         STH   R6,XS
         LA    R13,2(R13)
         LH    R6,0(R13,R10)
         STH   R6,YS
         LH    R8,NPTS
         LA    R8,1(C,R8)
         STH   R8,NPTS
         LH    R7,YT                   Y THIN   THIN TRACK
         LH    R8,DEL                  MIN THIN DIFF
         RCS   THINN,E*+4
         CH    R7,YT
         BC    8,YSMALL
         B     OK
YSMALL   LH    R6,XS                   X SMCOTH
         LH    R7,XT                   X THIN
         LH    R8,DEL                  MIN THIN DIFF
         RCS   THINN,E*+4
         CH    R7,XT
         BC    8,SMALL
*HERE IF NEW POINT ACCEPTEC IN THIN TRACK
CK       EQU   *
         RCS   TCRNRA,I11,E*+4
         LH    R11,YS
         LH    R10,YT
         STH   R11,YT
         SR    R11,R1C
         STH   R11,DY                  ST DELTA Y
         LPR   R11,R11
         STH   R11,MDY                 ST MAG(DELTA Y)
         LH    R11,XS
         LH    R7,XT
         STH   R11,XT
         SR    R11,R7
         STH   R11,DX                  ST DELTA X
         LPR   R11,R11
         STH   R11,MDX                 ST MAG(DELTA X)
NUINK    LH    R7,XT                   STORE NEW INK
         LH    R9,YT
         LH    R10,XL
         LH    R11,YL
         STH   R10,XLO
         STH   R11,YLO
         L     R4,DATA
         L     R15,INC
         SRL   R15,26
         LA    R14,3
         NR    R15,R14
         LA    R15,1(R15)
         RCS   TRAVC,E*+4
         C     R0,HEX10
         BC    8,INKST
         LR    R8,R0                   INCREMENT CNT FOR THIS DIRECTION
         SLL   R8,1
         LH    R7,D0(R8)
         LA    R7,1(R7)
         STH   R7,D0(R8)
         LH    R7,DN                   INCREMENT TOTAL COUNT
         LA    R7,1(R7)
         STH   R7,DN
         STH   R0,AX
         STH   R10,XL
         STH   R11,YL
         L     R4,DATA
         LH    R15,INKL
         BCT   R15,A1
A1       L     R4,DATA                 TEST FOR NO INKING
         TM    INC,X'80'
         BC    1,STOINK
         L     R4,DATA
         L     R7,ICP
         LA    R8,2
         STH   R8,6(R7)
         SR    R12,R12                 CLEAR INK COUNT
         B     NOSTO
STOINK   EQU   *
         L     R4,DATA
         L     R7,ICP
         LH    R8,6(R7)
         LA    R8,1(R8)
         STH   R8,6(R7)
         L     R4,DATA
         O     R0,HEX90
         L     R6,INKB
         STC   R0,0(R12,R6)
         SRL   R0,8
         LA    R12,1(R12)
         STC   R0,1(R6,R12)
NOSTO    EQU   *
*GEOMETRIC CORNER DETECTOR
         LH    R7,AX
         SH    R7,AX1
         LPR   R7,R7
         STH   R7,AX01
         CLI   AX3+1,X'10'
         BC    8,SHIFT
         RCS   CORNR,II1,E*+4
SHIFT    MVC   AX3(12),AX2
         CR    R12,R15
         BC    4,NUINK
         SR    R12,R12
*UPDATE STROKE BOX SIZE AND LOCATION
INKST    RCS   MAXMNS,II1,E*+4
*UPDATE RELATIVE MAX AND MINS
         RCS   RELMA,II1,E*+4
*
*
****ANGLE SECTION START****
*
*
*
*   DETERMINE QUADRANT
*
         LH    R6,DX                           MEASURE ANGLE=ANG
         LTR   R6,R6
         BC    4,DXNEG
         LH    R6,DY                           DX POS, TEST SIGN DY
         LTR   R6,R6
         BC    4,DYNEG
*DX,DY POS, QUAD=0
         SR    R6,R6
         B     QTEST
*DX POS, DY NEG, QUAD=3
DYNEG    LA    R6,3
         B     QTEST
DXNEG    LH    R6,DY                           DX NEG, TEST SIGN OF DY
         LTR   R6,R6
         BC    4,DYNEGG
         LA    R6,1
         B     QTEST
DYNEGG   LA    R6,2                            DX, DY NEG, QUAD=2
         B     QTEST
*
*   DETERMINE DIRECTION
*   AND CHECK FOR 2 EQUAL SUCCESSIVE ANGLES
*
QTEST    CH    R6,PQUAD
         BC    8,QEQPQ                         B IF QUAD=PREVQ
         STH   R6,PQUAD                        SET PQUAD=QUAD
         LH    R6,MDX
         CH    R6,MDY
         BC    4,ODDANG                        B IF MDX LESS THAN MDY
EVANG    LH    R6,DX                           ANG EVEN, TEST SIGN(DX)
         LTR   R6,R6
         BC    4,ANG2
         SR    R6,R6                 DX POS, ANG=0 RIGHT
         B     PRVANG
ANG2     LA    R6,2                  DX NEG, ANG=2 LEFT
         B     PRVANG
ODDANG   LH    R6,DY                 ANG ODD, TEST SIGN(DY)
         LTR   R6,R6
         BC    4,ANG3
         LA    R6,1
         B     PRVANG
ANG3     LA    R6,3                  DY NEG, ANG=3 DOWN
         B     PRVANG
QEQPC    STH   R6,PQUAD              QUAD=PREV QUAD, HYSTERESIS
         LH    R6,PANG
         LA    R7,1
         NR    R6,R7                 AND PANG WITH 1
         BC    8,EVPANG              B IF PREV ANG EVEN
*PREV ANGLE ODD
         LH    R6,MDX
         LH    R7,MDY
         RCS   HYSTR,E*+4
         BC    2,EVANG               B IF 3/4 MDX GTR MDY
         B     PRVTST
EVPANG   LH    R6,MDY                PREV ANGLE EVEN
         LH    R7,MDX
         RCS   HYSTR,E*+4
         BC    2,ODDANG              B IF 3/4 MDY GTR MDX
         B     PRVTST
PRVANG   CH    R6,PANG               DOES ANG=PREV ANG
         BC    8,PRVTST              B IF ANG=PANG
         LR    R9,R6
         RCS   TURNA,II1,E*+4
         LR    R6,R9
         STH   R6,PANG               SET PANG=ANG
         B     SMALL
PRVTST   EQU   *
         LH    R6,PANG               ANG=PREVANG
         CH    R6,PACANG
         BC    8,SMALL
         STH   R6,PACANG
*# ANGLES OVERFLOW TEST
         LH    R7,N                  # OF ANGLES
         LA    R8,15
         CR    R7,R8
         BC    4,NLOW                N LESS THAN 15
         MVI   CHAR,X'72'            CHAR IS A SCRUB
         SR    R7,R7
NLOW     L     R10,CODE
         LH    R9,TTURN
         L     R11,TURN
         LA    R8,16
         SR     R8,R7
SHFT     SRL    R10,2
         SRL    R11,2
         BCT    R8,SHFT
         SLL    R10,2
         SLL    R11,2
         LH     R6,PANG
         OR     R10,R6
         OR     R11,R9
         LA     R8,15
         SR     R8,R7
SHFT1    SLL    R10,2
         SLL    R11,2
         BCT    R8,SHFT1
         ST     R10,CODE
         ST     R11,TURN
         MVI    TTURN+1,X'00'
         LA     R7,1(R7)
         STH    R7,N                         INC N
         B      SMALL
*
*
****ANGLE SECTION END****
*
*
SMALL    LA     R13,2(0,R13)                 HERE PROCESSING OF NEW RAW COMP
         L      R4,DATA
         LH     R10,INPL
         CR     R13,R10
         BC     4,ENTER                      GET NEXT POINT
         STH    R12,INKIND                   KEEP INK BUFF IND
*
*
****WAIT FOR NEXT DATA POINT GROUP****
*
*
WATR1    WATE   PSG=WAITBX,CNTX=F
         L      R4,DATA
         TM     IND,X'10'
         BC     1,GOFINX
         L      R6,INKB
         IC     R15,IND
         LA     R14,X'0C'
         NR     R15,R14
         LA     R14,64
         OR     R14,R15
         STC    R14,5(R6)
         LA     R15,4(R15)
         SLL    R15,1
         STH    R15,DEL
NOFIN    NI     PUP+1,X'C7'
```

```
         B     WAITZ
*
*
****PEN UP SIGNAL****
*
*
IND2     NI    PUP+1,X'FE'             HERE CN PU TRAP
         LH    R7,DN                   TEST FOR INK
         LTR   R7,R7
         BC    8,NOSANG                NO INK
         CLI   N+1,X'CO'               TEST FCR PERIOD
         BC    6,PTEST                 NCT PERIOD
*TEST FCR SINGLE ANGLE
         LA    R7,4
         CH    R7,PANG
         BC    8,NOSANG
         LA    R7,1
         STH   R7,N
         LH    R10,PANG
         LH    R11,PANG
         LA    R8,3
SHFT2    SLL   R10,2
         AR    R10,R11
         BCT   R8,SHFT2
         SLL   R10,8
         ST    R10,CCDE
         BC    15,PTEST
*UPCATE STRCKE SIZE TC PREPARE FOR CENTER, ETC.
NCSANG   LH    R6,XS
         STH   R6,XLS
         STH   R6,XRS
         LH    R6,YS
         STH   R6,YTS
         STH   R6,YBS
*STRCKE IS A COT
*IS THIS THE 2ND STROKE OF A SCRIPT I OR J
         CLI   SN+1,X'02'
         BC    6,PTEST
         RCS   DOTA,II1,ECASE1,EPTEST
*MAKE POSITICN DECISICN HERE, 1ST CHECK FCR SINGLE STROKE
PTEST    LA    R7,1
         CH    R7,SN
         BC    10,CASE1                ONLY 1 STRCKE
*CAN OLD CHAR BE COMBINED WITH ANY STROKE, I.E. IS THERE A P AND/OR PAD
         L     R7,PAD
         LTR   R7,R7
         BC    6,NOTOK
         CLI   P,X'CO'
         BC    8,TOBIG
*CAN OLD CHAR BE COMBINED WITH STROKE
NCTCK    RCS   ANG4A,II1,E*+4
```

```
         RCS   CHECKA,II1,ETOBIG,ECOMBOK
*OLD CHAR CAN BE COMBINED WITH THIS STROKE, TEST FOR COMMA
COMBOK   CLI   N+1,X'01'
         BC    6,COMOK1     NOT 1 ANG
         TM    CODE,X'C0'
         BC    8,COMOK1 RIGHT HORIZ
         BC    4,COMOK2     UP OR LEFT HORIZ.
         LH    R15,DYM
         SRL   R15,2
         LH    R7,YTS
         SH    R7,YBS
         CR    R7,R15
         BC    10,COMOK1    NOT SHORT
*SHORT VERTICAL, IS IT AT THE BOTTOM
         LH    R7,YBS
         CH    R7,YBC
         BC    2,COMOK1     NO
*YES, DOES IT SLANT TO THE LEFT, I.E. IS ENDPT TO LEFT OF STARTPT
         LH    R8,SN
         BCT   R8,SLFT
SLFT     SLL   R8,1
         LH    R7,XSP(R8)
         CH    R7,XT
         BC    4,COMOK1
*SPECIAL TEST FOR T, IS THE FIRST STROKE A MINUS?
         CLI   P,X'02'
         BC    8,COMOK1
         B     TOBIG
*TEST FOR HORIZ. COMMA
COMOK2   TM    CODE,X'80'
         BC    8,COMOK1 UP
*LEFT HORIZ., IS IT AT THE BOTTOM
         LH    R7,YBS
         CH    R7,YBC
         BC    2,COMOK1     NO
         BC    12,TOBIG     YES,COMMA
*STROKE NOT A COMMA
COMOK1   LH    R7,XRC
         CH    R7,XLS
         BC    4,CASE1C
         CH    R7,XRS
         BC    4,CASE1B
         LH    R7,XLC
         CH    R7,XRS
         BC    4,CASE1
CASE1C   CLI   SN+1,X'02'          NO, IS OLD CHAR VERTICAL
         BC    6,TSTS2
         CLI   P,X'01'
         BC    8,CASE1A
TSTS2    CLI   N+1,X'01'           NO, IS NEW STROKE VERTICAL
         BC    6,TOBIG
         TM    CODE,X'C0'
         BC    12,TOBIG
         CLI   CHAR,X'CE'               YES, IS OLD CHR A PLUS
         BC    8,CASE1E
         CLI   CHAR,X'D2'               NO, IS IT A K
         BC    8,CASE1E
         BC    6,TOBIG
*1ST STROKE IS A VERTICAL, IS IT A 1
CASE1A   CLI   CHAR,X'F1'
         BC    8,CASE1B
         CLI   CHAR,X'E1'               NO, IS IT A SLASH
         BC    8,CASE1B
         CLI   CHAR,X'DD'               NO, IS IT A R. PAREN.
         BC    8,CASE1B                 YES
         CLI   CHAR,X'CD'               NO, IS IT A L. PAREN.
         BC    6,TOBIG
*TEST FOR SHORT VERT SECOND STROKE
CASE1B   CLI   N+1,X'01'
         BC    6,CASE1D                 NOT SINGLE ANGLE
         TM    CODE,X'C0'
         BC    12,CASE1D                NOT VERT
CASE1E   LH    R15,DYM                  2ND VERT, IS IT SHORT
         SRL   R15,2
         LH    R7,YTS
         SH    R7,YBS
         CR    R7,R15
         BC    4,TOBIG
*NO, IS DIFF BETWEEN CENTERS GTR R RASTERS
*GET HERE WHEN
*FIRST STROKE VERT, SECOND NOT
*AND FIRST STROKE RIGHT CLOSE TO SECOND LEFT
*OR BOTH STROKES VERTICAL
CASE1F   EQU   *
         LH    R15,WIDTH
         LR    R10,R15
         SRL   R10,1
         AR    R15,R10                  R =3/4 WIDTH
         LH    R7,XRC
         AH    R7,XLC                   2 OLD CENTER
         LH    R8,XRS
         AH    R8,XLS                   2 NEW CENT
         LR    R9,R8
         SR    R8,R7
         LPR   R8,R8
         CR    R8,R15
         BC    12,CASE1
*YES, IS DIFF GTR R1(R1 GTR R) RASTERS
         LH    R15,WIDTH
         SLL   R15,1                    R1 = WIDTH
         CR    R8,R15
         BC    2,TOBIG
```

```
*IS NEW XCENT IN LEFTMOST 1/4 OF A GRID POS?
         LH    R15,WIDTH
         SRL   R15,3                  CHAR WIDTH IN RASTERS
         SR    R8,R8
         SRL   R9,3                   NEW XCENT IN RASTERS
         DR    R8,R15                 NEW XCENT MOD(WIDTH)
         LR    R10,R15
         SRL   R10,2                  1/4 WIDTH
         CR    R8,R10                 REMAINDER IN R8
         BC    4,CASE1
*IS OLD X CENT IN RIGHTMOST 1/4 OF A GRID POS
         SR    R6,R6
         SRL   R7,3                   OLD XCENT IN RASTERS
         DR    R6,R15                 OLD XCENT MOD(WIDTH)
         SR    R15,R10
         CR    R6,R15                 3/4 WIDTH
         LA    R10,11
         CR    R6,R10                 REMAINDER IN R6
         BC    2,CASE1
         BC    12,TOBIG
*2ND STROKE IS NOT VERTICAL
*IS DIFF BETWEEN 2ND STROKE LEFT AND 1ST STROKE RIGHT GTR R RASTERS
CASE1D   EQU   *
         LH    R15,WIDTH
         SRL   R15,2
         LR    R10,R15
         SRL   R10,1
         AR    R15,R10                R = 3/8 WIDTH
         LH    R7,XLS
         SR    R7,R15
         CH    R7,XRC
         BC    2,TOBIG
         BC    12,CASE1F
*
*
****MULTI-STROKES****
*
*
CASE1    RCS   MAXMNC,II1,E*+4
*
*
****NEW CHARACTER PARAMETERS****
*
*
REINK    LH    R7,INKIND
         STH   R7,INKC
MORCHR   LH    R8,SN                  ENDPOINTS
         BCT   R8,REDR8
REDR8    SLL   R8,1
         LH    R6,XT
         STH   R6,XEP(R8)
         LH    R6,YT
         STH   R6,YEP(R8)
         RCS   DELT,II1,E*+4
*QUANTIZE REL MAX AND MINS
         RCS   QMMA,II1,E*+4
*SET UP I1 AS A TRANSLATION OF CODE
         RCS   ANG4A,II1,E*+4
         CLI   I1+3,X'EF'
         BC    6,ANG56X
EF13     MVI   I1+3,X'13'
ANG56X   RCS   ANG56,II1,E*+4
         LH    R7,DXC
         LTR   R7,R7
         BC    8,ASPR3
         SR    R8,R8
         LH    R9,DYC
         SLL   R9,2
         DR    R8,R7
         LR    R7,R9
         B     ASPR2
ASPR3    LA    R7,4095
         SLL   R7,4
ASPR2    STH   R7,ASPR
         LH    R8,NC                    # CORNERS
NTC1     STH   R8,NCUSP
NTX      EQU   *
*NO. OF TIME CORNERS
         LH    R8,NT
         BCT   R8,TNT1
TNT1     CH    R8,NTC
         BC    2,TNTX
         LH    R8,NTCUSP
         BCT   R8,TNTC1
TNTC1    STH   R8,NTCUSP
TNTX     EQU   *
         LH    R7,YTC
         AH    R7,YBC
         SRL   R7,1
         LH    R8,XRC
         AH    R8,XLC
         SRL   R8,1
         SLL   R8,16
         AR    R7,R8
         ST    R7,CENT
*TEST FOR SPECIAL CHARACTERS
         CLI   SN+1,X'02'
         BC    6,TSTSCB
         CLI   CHAR,X'89'               SCRIPT I
         BC    8,RECRTN
         CLI   CHAR,X'91'
         BC    6,TSTSCB
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*SCRIPT J
         RCS   RAZEA,II1,ERECRTN
TSTSCB   EQU   *
         CLI   CHAR,X'72'              TEST FOR SCRUB (N GTR 15)
         BC    8,RECRTN
         CLI   N+1,X'08'
         BC    12,CALREC
*N GTR 8, CHARACTER IS A POTENTIAL SCRUB
*IF N GTR 12, , OR CHARACTER IS LARGE, SET CHAR=SCRUB
*OTHERWISE ALLOW FOR A POSSIBLE SCRIPT CHARACTER
         CLI   N+1,X'0C'
         BC    2,SCBX
         LH    R8,DYM
         CH    R8,DYC
         BC    4,SCBX                  DYC GTR DYM
         CH    R8,DXC
         BC    10,CALREC               DXC LSS DYM
SCBX     EQU   *
         MVI   CHAR,X'72'
         B     RECRTN
*
*
****REC CALL****
*
*
CALREC   INST  AREC,RECA,II1,II1,ERECRTN
*
*
****MULTI-CHARACTERS****
*
*
TOBIG    LH    R7,INKC
         LH    R8,INKIND
         CR    R8,R7
         BNH   OVR2
         SR    R8,R7
         STH   R8,INKIND
         L     R4,DATA                 MOVE INK
         L     R9,ICP
         LH    R10,6(R9)
         SR    R10,R7
         LA    R11,2
         STH   R11,6(R9)
         L     R6,INKB
MOVINK   STC   R8,MVC+1
         LA    R7,0(R7,R6)
         EX    0,MVC
         L     R4,DATA                 DON'T UPDATE CCW COUNT IF NO INK
         TM    IND,X'80'
         BE    OVR21
         STH   R10,6(R9)
         B      OVR2
*
*
****ZERO INK COUNT****
*
*
OVR21    XC     INKIND(2),INKIND
*
*
****DON'T RESTORE****
*
*
OVR2     OI     PUP+1,X'30'
*
*
****2 CHARACTERS****
*
*
ALPHA    L      R4,DATA                  TEST FOR NO RECOGNITION
         TM     IND,X'40'
         BC     8,WATR1
         CLI    CHAR,X'EF'               CK IF CHAR OR NO CHAR
         BC     8,NCEXT                  NO CHAR
         TM     PUP+1,X'20'
         BC     8,TCE                    NO MORE DATA TAKE TERMINAL
         PARL   CNTX=F,LOW=PHI,HIGH=CHARX
*
*
****RESET FOR NEW CHARACTER****
*
*
*RESET CHAR SIZE, LOCATION, ETC.
PHI      MVC    DXC(12),DXS
         LH     R6,SN
         BCT    R6,DECR6
DECR6    SLL    R6,1
         LH     R7,XSP(R6)
         STH    R7,XSP
         LH     R7,YSP(R6)
         STH    R7,YSP
         LA     R6,1
         STH    R6,SN
         XC     P(1),P
         XC     PAD(4),PAD
         XC     CHAR(1),CHAR
         L      R4,DATA
         L      R7,CET
         STH    R7,YCENT
         MVC    PCHAR(1),CHARA
         B      REINK
*
```

```
*
****REC EXIT****
*
*
*REC EXITS TO HERE
RECRTN   EQU   *
*IF N GTR 8 AND CHAR IS NOT A SCRIPT CHARACTER, SET CHAR=SCRUB
         CLI   CHAR,X'A9'
         BC    2,SCBX2
         CLI   CHAR,X'81'
         BC    10,SCRPT
SCBX2    EQU   *
         CLI   N+1,X'08'
         BC    12,RCRTN1
         MVI   CHAR,X'72'
         B     RCRTN1
SCRPT    EQU   *
*THIS IS A SCRIPT CHARACTER
*
*THE FOLLOWING CODE CONVERTS A LOWER CASE CHARACTER TO THE SAME
*UPPER CASE CHARACTER
         OI    CHAR,X'40'
RCRTN1   EQU   *
         NI    PUP+1,X'CF'
         L     R4,INDEX                PRESET EXPIRATION = TIME
         MVI   3(R4),X'01'
*SKIP AROUND THE CLOCK IF CHAR IS A GEOMETRIC SYMBOL, I.E. INK VECTOR
*  SIZE IS 8 RASTERS
         L     R4,DATA
         TM    IND,X'0C'
         BC    1,CLEXF
NOSKIP   EQU   *
         OI    PUP+1,X'04'             IND CLOCK RUNNING
RECX     INST  CLK1,CLK2,FWAITBX,ITIME,ECLEXP,ECLEXF
*
*
****CLOCK EXPIRED (DUE TO RUNNING LONGER THEN TIME)****
*
*
CLEXP    EQU   *
SETCK    EQU   *
         SET   PSG=WAITBX,CNTX=F       TURN OFF CLOCK
         PAWS
*
*
****CLOCK TURNED OFF (DUE TO PENDOWN)****
*
*
CLEXF    EQU   *
         L     R4,DATA
         TM    IND,X'10'
         BC    1,GOFINX
         NI    PUP+1,X'FB'             HALT CLOCK EXIT
         TM    PUP+1,X'02'
         BC    1,FINSH
         BAL   R15,OUTPTS
         TM    PUP+1,X'10'             CHECK IF PENDING CHAR EXIT
         BC    1,ALPHA
         L     R4,INDEX
         CLI   3(R4),X'00'             WHY CLOCK EXPIRED
         BC    8,WAITZ                 MORE DATA
         MVI   PUP+1,X'00'             RESET ALL INIICATIORS
         B     ALPHA
*
*
****FINISH ENTRY 1****
*
*
FIN      TM    PUP+1,X'04'             CALLER INDICATES TO FINISH
         BC    8,FINSH
         OI    PUP+1,X'02'
         BC    15,SETCK                SET BOX FOR CLOCK
*
*
****SET UP OUTPUTS****
*
*
OUTPTS   L     R4,DATA
         MVC   EP(2),XSP
         MVC   EP+2(2),YSP
         MVC   EP+4(2),XEP
         MVC   EP+6(2),YEP
         L     R4,DATA                 OUTPUT CHAR
         MVC   CHARA(1),CHAR
         L     R7,CENT                 OUTPUT CENTER
         ST    R7,CET
         MVC   AR(1),NCUSP+1           AR, CHAR SIZE
         MVC   AR+1(1),ASPR+1
         MVC   SIZE(2),DXC
         MVC   SIZE+2(2),DYC
         BR    R15
*
*
****NO CHARACTER****
*
*
NCEXT    EQU   *
         TM    PUP+1,X'20'
         BC    8,TNE                   TERMINAL EXIT NO MORE DATA
         PARL  CNTX=F,LOW=PHI,HIGH=NCHARX
*
*
```

```
****FINISH ENTRY 2****
*
*
FINSH    BAL   R15,OUTPTS
*
*
****FINISH ENTRY 3****
*
*
GOFINX   EQU   *
         BAL   R15,OUTINK
         EPLOG FINX
*
*
****TERMINAL CHARACTER****
*
*
TCE      EQU   *
         BAL   R15,OUTINK
         EPLOG XTC
*
*
****TERMINAL NO CHAR****
*
*
TNE      EQU   *
         BAL   R15,OUTINK
         EPLOG XTN
*
*
****SET UP INK****
*
*
CUTINK   EQU   *
         L     R4,DATA
         TM    IND,X'CC'
         BC    1,OUTSKP
         L     R7,ICP
         LA    R8,2
         STH   R8,6(R7)
OUTSKP   EQU   *
         BR    R15
*
*
****END OF CHAREC****
*
*
         END
```

CHAREC RCS's

ANG4

```
*FUNCTION
*
*TRANSLATES THE FIRST FOUR STYLUS DIRECTIONS (IN CODE) TO A 1-BYTE
*INDEX (IN I1+3) CORRESPONDING TO A SET OF POTENTIAL STROKES.
*FO=NOT ALLOWABLE, 13=DON'T KNOW
*
*
*
*CALL
*        RCS   ANG4A,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7,R8,R10
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
I1       DS    1F
         DS    1F
CODE     DS    1F
         DS    5F
N        DS    1F
ANG4     BOX
         LA    R10,8
         SH    R10,N
         BC    12,ANGOUT
         LH    R7,CODE
SRGT     SRL   R7,2
         BCT   R10,SRGT
         LA    R8,3
         NR    R8,R7
         LA    R10,8
         SH     R10,N
SLFT     SLL    R7,2
         OR     R7,R8
         BCT    R10,SLFT
         STH    R7,CODE
ANGOUT   MVC    I1+3(1),CODE
         TR     I1+3(1),THET4
ANGE     BEXIT  EX0
THET4    DS     0H
         DC     X'0C'        0000 SBARM
         DC     15C'0'       ILLEGAL
         DC     2X'13'                 0100-0101 DK
         DC     X'40'                  0102 RSC
         DC     X'3F'                  0103 SCRPT
         DC     C'0'         0110 ILLEGAL
         DC     X'13'        0111 DK
         DC     2C'0'        ILLEGAL
         DC     X'13'        0120 DK
         DC     X'21'        0121 S5
         DC     X'13'        0122 DK
         DC     X'3E'                  0123 S09M
         DC     X'3D'                  0130 S9LC1
         DC     X'41'                  0131 SCPFP
         DC     X'43'                  0132 RSS
         DC     X'42'                  0133 SCPEL
         DC     2X'0D'        0200,0201 S2MRZ
         DC     X'2A'        0202 S3SCRB
         DC     2X'0F'       0203,0210 S3MBR
         DC     3X'0D'        0211-0213 S2MRZ
         DC     2C'0'        ILLEGAL
         DC     X'2D'        0222 SLKRTM
         DC     C'0'
         DC     X'02'    0230 S23MB
         DC     X'0D'    0231 S2MRZ
         DC     X'0E'    0232 S3MB
         DC     X'14'        0233 S7MGK
         DC     X'0D'        0300 S2MRZ
         DC     X'32'                  0301 S8
         DC     X'0E'                  0302 S3MB
         DC     X'0F'        0303 S3MBR
         DC     X'44'                  0310 RSV
         DC     X'49'                  0311 S8LCV
         DC     X'40'                  0312 RSC
         DC     X'01'    0313 STPM
         DC     X'02'                  0320 S23MB
         DC     X'3B'                  0321 S023MB
         DC     X'12'        0322 SRPRM
         DC     X'0D'         0323 S2MRZ
         DC     3C'0'
         DC     X'14'        0333 S7MGK
         DC     X'1E'        1000 SFE
DC    3C'0'
DC    X'13'         1010 DK
DC    X'13'     1011 DK, POSSIBLY TILDA
DC    X'13'                    1012 DK
DC    X'13'                    1013 DK
DC    X'02'                    1020 S23MB
DC    X'0E'                    1021 S3MB
DC    X'13'                    1022 DK
DC    X'02'         1023 S23MB
DC    X'0F'         1030 S3MBR
DC    X'45'                    1031 SCPNRZ
DC    X'03'         1032 S23MBP
DC    X'38'         1033 SA7
DC    5C'0'
DC    X'16'         1111 S1MAK
DC    10C'0'
DC    2X'13'        1200,1201 DK
DC    2X'1B'        1202,1203 SSM
DC    4X'13'        1210-1213 DK
DC    2C'0'
DC    X'13'         1222 DK
DC    C'0'
DC    X'04'         1230 SMC
DC    X'32'         1231 S8
DC    X'05'         1232 SS8M
DC    X'15'          1233 STPA
DC    X'11'     1300 S24
DC    X'17'         1301 SNMA
DC    2X'35'        1302,1303 S3
DC    X'0D'         1310 S2MRZ
DC    X'17'         1311 SNMA
DC    X'36'         1312 SASTAR
DC    X'18'                    1313 SMLC
DC    X'36'         1320 SASTAR
DC    X'0D'         1321 S2MRZ
DC    X'13'                    1322 DK
DC    X'46'                    1323 RSZ
DC    3C'0'
DC    X'19'         1333 SCOMAM
DC    X'1A'         2000 SBARMK
DC    3C'0'
DC    X'33'         2010 SG
DC    X'06'         2011 SG069M
DC    X'08'         2012 SG06M
DC    X'34'         2013 S9
DC    X'29'         2020 SGSCRB
DC    X'1B'         2021 SSM
DC    X'30'         2022 SGS06M
DC    X'47'                    2023 SE
DC    X'4A'                    2030 SEQ
DC    X'48'                    2031 SCPGQ
DC    X'05'       2032 SS8M
DC    X'1C'        2033 S9MK
DC    3X'13'      2100-2102 DK
DC    X'3C'                 2103 S09
DC    C'0'
DC    X'13'       2111 DK
DC    2C'0'
DC    8X'13'      2120-2133 DK
DC    10C'0'
DC    X'0C'       2222 SBARM
DC    5C'0'
DC    X'1D'       2300 SCMEG
DC    X'06'       2301 SG069M
DC    X'2F'       2302 SGS
DC    X'07'       2303 SS589M
DC    X'22'       2310 STP5
DC    X'32'       2311 S8
DC    X'33'       2312 SG
DC    X'07'       2313 SS589M
DC    2X'32'      2320,2321 S8
DC    X'1B'       2322 SSM
DC    X'47'                 2323 SE
DC    3C'0'
DC    X'1E'       2333 SFE
DC    X'1F'       3000 SLMEK4
DC    3C'0'
DC    X'3A'                 3010 SG81
DC    X'20'       3011 SUMJU
DC    X'08'       3012 SG06M
DC    X'27'       3013 SUMAM
DC    2X'22'       3020,3021 STP5
DC    X'10'       3022 STP6
DC    3X'22'    3023-3031  STP5
DC    X'22'       3032 STP5
DC    X'23'       3033 SK5
DC    X'24'       3100 STPH
DC    X'13'       3101 DK
DC    X'2C'       3102 SBDPR1
DC    X'09'       3103 SBDPR
DC    C'0'
DC    X'25'       3111 SVM
DC    2C'0'
DC    2X'24'      3120,3121 STPH
DC    X'26'       3122 SDMH
DC    X'39'       3123 SCG
DC    X'28'       3130 BR
DC    X'0A'       3131 SMNW
DC    X'2C'       3132 SBDPR1
DC    X'27'       3133 SUMAM
DC    4X'13'      3200-3203 DK
DC    X'3C'                 3210 S09
```

```
         DC     X'28'           3211 STPJ
         DC     2X'34'          3212,3213 S9
         DC     2C'0'
         DC     X'2E'           3222 SRPRMJ
         DC     C'0'
         DC     X'37'           3230 SCC
         DC     X'32'                          3231 S8
         DC     X'35'           3232 S3
         DC     X'13'           3233 DK
         DC     15C'0'
         DC     X'0B'           3333 SM1M
         END
```

CHECK

```
*FUNCTION
*
*CHECKS TO SEE IF THE PREVIOUS SUBCHARACTER (PREV. 'REC' OUTPUT) CAN BE
*COMBINED WITH THE CURRENT STROKE (AS ENCODED FROM THE FIRST FOUR
*DIRECTIONS BY 'ANG4') TO FORM ONE OF THE ALLOWABLE CHARACTERS.
*
*
*
*CALL
*        RCS    CHECKA,II1,ENO,EYES
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
* I1+3 CONTAINS THE STROKE CODE
* EXIT NO WHEN STROKE AND SUBCHARACTER CANNOT BE COMBINED
* EXIT YES WHEN STROKE AND SUBCHARACTER CAN BE COMBINED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7 THRU R10
*
*
         USING XR6,R6
EX0      EQU    0
EX4      EQU    4
         REGS
D6       DSECT
XR6      DS     0F
I1       DS     1F
         DS     2F
         DS     11H
```

```
SN        DS     1H
          DS     14H
          DS     20C
          DS     3F
          DS     1H
          DS     2C
          DS     3H
P         DS     1C
CHAR      DS     1C
CHECK     BOX
          SR     R8,R8
          IC     R8,I1+3
          BCT    R8,MULT
MULT      SLL    R8,2          4 TIMES (I1-1)
          EX     0,CHKTAB(R8)
CK        SR     R8,R8
          IC     R8,CHAR
*ALL VE   RTICALS TREATED THE SAME
          CLI    SN+1,X'02'
          BC     6,CK2
          CLI    P,X'01'
          BC     8,CK1
          CLI    P,X'09'
          BC     6,CK2
*OLD CH   AR IS VERT
*CHANGE    CHAR CODE TO 1
CK1       LA     R8,1
CK2       SR     R9,R9
          SR     R10,R10
CK3       IC     R10,0(R7)
          CR     R10,R9
          BC     8,CKX
          CR     R10,R8
          BC     8,CKOK
          LA     R7,1(R7)
          BC     15,CK3
*END OF    POSSIBLE OLD-CHAR LIST
CKOK      BEXIT EX4
CKX       BEXIT EX0
CHKTAB    DS     0F
          LA     R7,S1         B1
          LA     R7,S2         B2
          LA     R7,S2         B3
          LA     R7,S10        B4
          LA     R7,S4         B5
          LA     R7,S10        B6
          LA     R7,S4         B7
          LA     R7,S10        B8
          LA     R7,S3         B9
          LA     R7,S4         B10
          LA     R7,S12        B11
LA     R7,S13        B12
LA     R7,S3         B13
LA     R7,S1         B14
LA     R7,S1         B15
LA     R7,S2         B16
LA     R7,S7                     B17(11)
LA     R7,S3         B18
LA     R7,S4         B19
LA     R7,S5         B20
LA     R7,S4         B21
LA     R7,S6         B22
LA     R7,S7         B23
LA     R7,S4         B24
LA     R7,S8         B25
LA     R7,S3         B26
LA     R7,S4         B27
LA     R7,S1         B28
LA     R7,S1         B29
LA     R7,S14        B30
LA     R7,S9         B31
LA     R7,S10        B32
LA     R7,S4         B33
LA     R7,S4         B34
LA     R7,S1         B35
LA     R7,S1         B36
LA     R7,S11        B37
LA     R7,S1         B38
LA     R7,S1         B39
LA     R7,S4         B40
LA     R7,S4         B41
LA     R7,S1         B42
LA     R7,S4         B43
LA     R7,S7         B44
LA     R7,S1         B45
LA     R7,S15                    B46
LA     R7,S10        B47
LA     R7,S10        B48
LA     R7,S10        B49
LA     R7,S4         B50
LA     R7,S4         B51
LA     R7,S4         B52
LA     R7,S4         B53
LA     R7,S4         B54
LA     R7,S4         B55
LA     R7,S4         B56
LA     R7,S4         B57
LA     R7,S4                     B58(3A)
LA     R7,S2                     B59(3B)
LA     R7,S2                     B60(3C)
LA     R7,S4                     B61(3D)
LA     R7,S10                    B62(3E)
```

```
         LA    R7,S4                  B63(3F)
         LA    R7,S4                  B64(40)
         LA    R7,S4                  B65(41)
         LA    R7,S4                  B66(42)
         LA    R7,S4                  B67(43)
         LA    R7,S4                  B68(44)
         LA    R7,S4                  B69(45)
         LA    R7,S4                  B70(46)
         LA    R7,S4                  B71(47)
         LA    R7,S4                  B72(48)
         LA    R7,S4                  B73(49)
         LA    R7,S4                  B74(4A)
         EJECT
S1       DS    0H
         DC    X'01'        1
         DC    X'00'
S2       DS    0H
         DC    X'01'        1
         DC    X'E0'        -
         DC    X'F0'        0
         DC    X'E4'        U
         DC    X'C3'        C
         DC    X'F6'        6
         DC    X'C7'        G
         DC    X'E2'        S
         DC    X'F5'        5
         DC    X'F8'        8
         DC    X'00'
S3       DS    0H
         DC    X'01'        1
         DC    X'E0'        -
         DC    X'00'
S4       DS    0H
         DC    X'00'
S5       DS    0H
         DC    X'01'        1
         DC    X'E0'        -
         DC    X'F0'        0
         DC    X'F6'        6
         DC    X'C3'        C
         DC    X'C7'        G
         DC    X'D2'        K
         DC    X'E3'        T
         DC    X'E5'        V
         DC    X'E7'        X
         DC    X'E8'        Y
         DC    X'CE'        +
         DC    X'CD'        (
         DC    X'E1'        /
         DC    X'00'
S6       DS    0H
```

```
       DC   X'01'     1
       DC   X'E0'     -
       DC   X'E7'     X
       DC   X'E8'     Y
       DC   X'E5'     V
       DC   X'D2'     K
       DC   X'F7'     7
       DC   X'DD'     )
       DC   X'00'
S7     DS   0H
       DC   X'E0'     -
       DC   X'00'
S8     DS   0H
       DC   X'01'     1
       DC   X'E0'     -
       DC   X'CE'     +
       DC   X'00'
S9     DS   0H
       DC   X'01'     1
       DC   X'E0'     -
       DC   X'D2'     K
       DC   X'FE'     =
       DC   X'F0'     0
       DC   X'F6'     6
       DC   X'C7'     G
       DC   X'E7'     X
       DC   X'E8'     Y
       DC   X'E5'     V
       DC   X'00'
S10    DS   0H
       DC   X'F0'     0
       DC   X'E4'     U
       DC   X'C3'     C
       DC   X'F6'     6
       DC   X'C7'     G
       DC   X'00'
S11    DS   0H
       DC   X'01'     1
       DC   X'E5'     V
       DC   X'D2'     K
       DC   X'E7'     X
       DC   X'E8'     Y
       DC   X'F0'     0
       DC   X'E4'     U
       DC   X'C3'     C
       DC   X'F6'     6
       DC   X'C7'     G
       DC   X'00'
*VERTICAL STROKE
S12    DS   0H
       DC   X'01'     1
```

```
         DC    X'E0'       -
         DC    X'D2'       K
         DC    X'E5'       V
         DC    X'E7'       X
         DC    X'E8'       Y
         DC    X'CE'       +
         DC    X'C9'       I
         DC    X'C6'       F
         DC    X'F0'       0
         DC    X'F6'       6
         DC    X'E4'       U
         DC    X'D3'       L
         DC    X'F7'       7
         DC    X'CD'       (
         DC    X'E1'       /
         DC    X'CC'       LSS
         DC    X'FE'       =
         DC    X'D5'       N
         DC    X'DC'       *
         DC    X'C1'       A
         DC    X'E2'       S
         DC    X'C3'       C
         DC    X'D7'       P
         DC    X'F8'       8
         DC    X'C7'       G
         DC    X'DB'       $
         DC    X'F5'                  5
         DC    X'F2'                  2
         DC    X'85'                  LC  E
         DC    X'89'                  LC  I
         DC    X'99'                  LC  R
         DC    X'A5'                  LC  V
         DC    X'86'                  LC  F
         DC    X'00'
*HORIZONTAL STROKE
S13      DS    0H
         DC    X'01'       1
         DC    X'E0'       -
         DC    X'D2'       K
         DC    X'E5'       V
         DC    X'E7'       X
         DC    X'E8'       Y
         DC    X'E3'       T
         DC    X'CE'       +
         DC    X'C9'       I
         DC    X'C6'       F
         DC    X'F5'       5
         DC    X'E2'       S
         DC    X'F2'       2
         DC    X'C3'       C
         DC    X'CF'       LBRAC
```

```
        DC    X'70'       KARAT
        DC    X'F7'       7
        DC    X'D3'       L
        DC    X'CD'       (
        DC    X'E1'       /
        DC    X'D1'       J
        DC    X'DD'       )
        DC    X'EE'       GTR
        DC    X'F0'       0
        DC    X'F6'       6
        DC    X'E4'       U
        DC    X'C2'       B
        DC    X'C4'       D
        DC    X'D7'       P
        DC    X'D9'       R
        DC    X'F8'                 8
        DC    X'F9'                 9
        DC    X'C1'                 A
        DC    X'85'                 LC E
        DC    X'86'                 LC F
        DC    X'89'                 LC I
        DC    X'93'                 LC L
        DC    X'88'                 LC H
        DC    X'C8'                 H
        DC    X'DC'                 *
        DC    X'00'
S14     DS    0H
        DC    X'01'       1
        DC    X'E0'       -
        DC    X'F7'       7
        DC    X'00'
S15     DS    0H
        DC    X'E0'                 -
        DC    X'F0'                 0
        DC    X'00'
        END
```

CORNER

```
*FUNCTION
*
*DETECTS CORNERS BASED ON SHARP CHANGES IN DIRECTION, AND UPDATES NC.
*OF GEOMETRIC CORNERS (NC) AND THE ARRAY OF POSITIONS OF GEOMETRIC
*CORNERS (XC,YC).
*USES 16-DIRECTION SEQUENCE AX THRU AX3 AND DIFFERENCES.
*INDEX C=0 IS WAIT FOR CORNER, C=1 IS POTENTIAL CORNER, C=2 IS JUST GOT
```

```
*CORNER.
*
*
*
*CALL
*         RCS    CORNERA,I11,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7 THRU R9
*
*
*
          USING XR6,R6
EX0       EQU    0
          REGS
D6        DSECT
XR6       DS     0F
          DS     3F
          DS     26H
          DS     20C
          DS     3F
          DS     1H
          DS     2C
          DS     3H
          DS     56C
          DS     2H
XLO       DS     1H
YLO       DS     1H
          DS     1H
AX2       DS     1H
          DS     1H
AX        DS     1H
AX23      DS     1H
AX12      DS     1H
AX01      DS     1H
AX02      DS     1H
NC        DS     1H
C         DS     1H
          DS     7H
          DS     1F
          DS     6C
          DS     1H
          DS     1F
XC        DS     10C
YC        DS     10C
CORNER    BOX
*CORNER    DETECTOR
```

```
         CLI   C,X'02'
         BC    8,COUT
         CLI   C,X'01'
         BC    8,CEQ1
         CLI   AX01+1,X'04'
         BC    4,AXP2
         CLI   AX01+1,X'0C'
         BC    2,AXP2
AX1EQ2   LH    R7,AX12
         STH   R7,AX02
         BC    15,IEQJ
AXP2     LH    R7,AX
         SH    R7,AX2
         LPR   R7,R7
         STH   R7,AX02
         CLI   AX02+1,X'04'
         BC    4,COUT
         CLI   AX02+1,X'0C'
         BC    2,COUT
         LH    R7,AX23
         STH   R7,AX02
IEQJ     CLI   AX02+1,X'01'
         BC    12,SETC1
         CLI   AX02+1,X'0F'
         BC    6,COUT
SETC1    CLI   C,X'01'
         BC    8,INCNC
         MVI   C,X'01'
**STORE   POSITION OF POTENTIAL CUSP
         LH    R9,NC
         LA    R8,5
         CR    R9,R8
         BC    4,NCLSS5
         SR    R9,R9
NCLSS5   SLL   R9,1
         LH    R8,XLO
         STH   R8,XC(R9)
         LH    R8,YLO
         STH   R8,YC(R9)
         BC    15,CEXIT
CEQ1     LH    R7,AX01
         STH   R7,AX02
         BC    15,IEQJ
INCNC    LH    R7,NC
         LA    R7,1(0,R7)
         STH   R7,NC
         MVI   C,X'02'
         BC    15,CEXIT
COUT     MVI   C,X'00'
CEXIT    BEXIT EXO
         END
```

DOT

```
*FUNCTION
*
*USED WHEN THE SECOND STROKE IS A DOT.
*DETERMINES IF THE FIRST STROKE RESULTS IN A SCRIPT I OR J.
*
*
*
*CALL
*         RCS   DOTA,II1,EYES,ENO
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
* EXIT YES WHEN SCRIPT I OR J
* EXIT NO WHEN NOT SCRIPT I OR J
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7 THRU R10
*
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
EX4      EQU   0
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    26H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
DOT      BOX
*2ND STROKE IS A DOT
*DOES 1ST STROKE RESULT IN A SCRIPT I OR J
*IF YES, TAKE EX0, OTHERISE EX4
         SR    R8,R8
         IC    R8,CHAR
         SR    R9,R9
         SR     R10,R10
         LA     R7,ILIST
CKLIST   EQU    *
         IC     R10,0(R7)
         CR     R10,R9
         BC     8,NOX                           NOT I OR J
         CR     R10,R8
         BC     8,IJX
         LA     R7,1(R7)
         B      CKLIST
IJX      LA     R8,JLIST
         CR     R7,R8
         BC     10,JX
IX       MVI    CHAR,X'89'
         B      YESX
JX       MVI    CHAR,X'91'
YESX     BEXIT  EX0
NOX      BEXIT  EX4
ILIST    DS     0F
         DC     X'89'                           I
         DC     X'85'                           E
         DC     X'A5'                           V
         DC     C'L'                            L
         DC     C'2'                            2
         DC     X'82'                           B
         DC     X'70'                           KARAT
JLIST    EQU    *
         DC     X'86'                           F
         DC     X'91'                           J
         DC     X'F8'                           8
         DC     X'E5'                           V
         DC     X'DD'                           RIGHT PAREN
         DC     X'00'                           END OF LISTS
         END
```

DELTAS

```
*FUNCTION
*
*QUANTIZES THE STARTING POINT AND ENDING POINT LOCATIONS OF EACH STROKE
*BY CONSIDERING THE CHARACTER REGION AS A 4 X 4 GRID CODED AS
*                                  YTC
*                           3   2   1   0
*                    XLC    7   6   5   4   XRC
*                          11  10   9   8
*                          15  14  13  12
*                                  YBC
```

```
*
*
*
*CALL
*          RCS    DELTASA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7 THRU R14
*
*
          USING XR6,R6
          REGS
EXO       EQU    0
D6        DSECT
XR6       DS     0F
          DS     3F
          DS     11H
SN        DS     1H
          DS     6H
XRC       DS     1H
XLC       DS     1H
YTC       DS     1H
YBC       DS     1H
          DS     4H
XYE       DS     10C
XYS       DS     10C
          DS     3F
          DS     1H
          DS     2C
          DS     3H
          DS     8C
XSP       DS     10C
YSP       DS     10C
XEP       DS     10C
YEP       DS     10C
DELTAS    BOX
          SR     R7,R7
          LA     R8,2
          LH     R9,SN
          SLL    R9,1
          BCT    R9,DEL1
DEL1      LH     R10,XRC
          SH     R10,XLC
          SRL    R10,2
          LH     R11,YTC
          SH     R11,YBC
```

```
         SRL    R11,2
DEL10    LA     R13,3
         LR     R14,R13
         LH     R12,XLC
DEL3     AR     R12,R10
         CH     R12,XSP(R7)
         BC     2,DEL2
         BCT    R13,DEL3
DEL2     LH     R12,YBC
DEL5     AR     R12,R11
         CH     R12,YSP(R7)
         BC     2,DEL4
         BCT    R14,DEL5
DEL4     SLL    R14,2
         OR     R13,R14
         STH    R13,XYS(R7)
         LA     R13,3
         LR     R14,R13
         LH     R12,XLC
DEL6     AR     R12,R10
         CH      R12,XEP(R7)
         BC     2,DEL7
         BCT    R13,DEL6
DEL7     LH     R12,YBC
DEL8     AR     R12,R11
         CH     R12,YEP(R7)
         BC     2,DEL9
         BCT    R14,DEL8
DEL9     SLL    R14,2
         OR     R13,R14
         STH    R13,XYE(R7)
         BXLE   R7,R8,DEL10
         BEXIT  EX0
         END
```

<u>FN56</u>

```
*FUNCTION
*
*PRODUCES INDEX IN BR56 BASED ON NO. OF DIRECTIONS (N) AND DIRECTIONS
*5 AND 6.
*N=4 GIVES BR56 = 16, OTHERWISE BR56 GETS BITS 8 THRU 11 OF CODE.
*
*
*
*CALL
```

```
*        RCS   FN56A,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
D6       DSECT
XR6      DS    0F
         DS    2F
CODE     DS    1F
         DS    10H
N        DS    1H
         DS    4H
BR56     DS    1H
FN56     BOX
         LA    R7,16
         STH   R7,BR56
         CLI   N+1,X'C5'
         BC    4,FN56E
         SR    R7,R7
         IC    R7,CODE+1
         SRL   R7,4
         STH   R7,BR56
FN56E    BEXIT EX0
         END
```

HYST

```
*FUNCTION
*
*TRANSFORMS STYLUS INCREMENTAL DISTANCE TO PROVIDE HYSTERESIS ZONES
*WHEN COMPUTING STYLUS DIRECTION.
*
*
*
*CALL
*        RCS   HYSTA,EEXIT
*
*
```

```
*
*INPUT REGISTERS
*
*C(R6) = SMALLER (EITHER X OR Y) INCREMENT
*C(R7) = LARGER (EITHER Y OR X) INCREMENT
*
*
*
*OUTPUT REGISTERS
*
*C(R8) = 3/4 LARGER INCREMENT - SMALLER INCREMENT
*
*
*
*INTERNAL REGISTERS.  NONE OTHER THAN THE ABOVE
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
HYST     BOX
         LR    R8,R6
         SRA   R6,2
         SR    R8,R6
         SR    R8,R7
         BEXIT EXO
         END
```

<u>MXMNC</u>

```
*FUNCTION
*
*UPDATES THE X BOUNDS (XLC,XRC) AND Y BOUNDS (YTC,YBC) OF THE CHARACTER
*
*
*
*CALL
*        RCS   MXMNCA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
```

```
*INTERNAL REGISTERS.  R7
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    16H
DXC      DS    1H
DYC      DS    1H
XRC      DS    1H
XLC      DS    1H
YTC      DS    1H
YBC      DS    1H
         DS    4H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    56C
         DS    17H
XRS      DS    1H
XLS      DS    1H
YTS      DS    1H
YBS      DS    1H
MXMNC    BOX
         LH    R7,XRS
         CH    R7,XRC
         BC    12,MAX1
         STH   R7,XRC
MAX1     LH    R7,XLS
         CH    R7,XLC
         BC    10,MAX2
         STH   R7,XLC
MAX2     LH    R7,YTS
         CH    R7,YTC
         BC    12,MAX3
         STH   R7,YTC
MAX3     LH    R7,YBS
         CH    R7,YBC
         BC    10,MAX4
         STH   R7,YBC
MAX4     LH    R7,YTC
         SH    R7,YBC
         STH   R7,DYC
         LH    R7,XRC
         SH    R7,XLC
         STH   R7,DXC
         BEXIT EXO
         END
```

MXMNS

```
*FUNCTION
*
*UPDATES THE X BOUNDS (XLS,XRS) AND Y BOUNDS (YTS,YBS) OF THE CURRENT
*STROKE
*
*
*
*CALL
*        RCS   MXMNSA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    2H
XT       DS    1H
YT       DS    1H
         DS    22H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    56C
         DS    15H
DXS      DS    1H
DYS      DS    1H
XRS      DS    1H
XLS      DS    1H
YTS      DS    1H
YBS      DS    1H
```

```
MXMNS     BOX
          LH    R7,XT
          CH    R7,XRS
          BC    12,MAX11
          STH   R7,XRS
MAX11     CH    R7,XLS
          BC    10,MAX22
          STH   R7,XLS
MAX22     LH    R7,YT
          CH    R7,YTS
          BC    12,MAX33
          STH   R7,YTS
MAX33     CH    R7,YBS
          BC    10,MAX44
          STH   R7,YBS
MAX44     LH    R7,YTS
          SH    R7,YBS
          STH   R7,DYS
          LH    R7,XRS
          SH    R7,XLS
          STH   R7,DXS
          BEXIT EXO
          END
```

QMM

```
*FUNCTION
*
*QUANTIZES YMAX (THE Y COORDINATE OF A RELATIVE MAXIMUM) ARRAY TO QYMAX
*ARRAY, AND QUANTIZES YMIN TO QYMIN.  THE QUANTIZATION INTERVAL IS 1/4
*CHARACTER HEIGHT WITH QYMAX = 0 IN THE TOP 1/4 OF THE CHARACTER, ETC.
*
*
*
*CALL
*         RCS   QMMA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7 THRU R14
*
*
          USING XR6,R6
```

```
         REGS
EX0      EQU   0
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    20H
YTC      DS    1H
YBC      DS    1H
         DS    4H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    56C
         DS    21H
         DS    1F
         DS    6C
         DS    1H
         DS    1F
         DS    20C
         DS    23H
YMAX     DS    10H
QYMAX    DS    10C
QMM      BOX
*NOTE THAT YMIN=YMAX+10, QYMIN=QYMAX+5
         SR    R7,R7
         LA    R8,2
         LA    R9,20                         2(5 MIN + 5 MAX)
         LH    R13,YTC
         SH    R13,YBC
         SRL   R13,2                         D= 1/4 CHAR HEIGHT
         LH    R10,YBC
         AR    R10,R13                       YBC + D
         LR    R11,R10
         AR    R11,R13                       YBC + 2D
         LR    R12,R11
         AR    R12,R13                       YBC + 3D
ALF      EQU   *
         LR    R14,R7
         SRL   R14,1
         LA    R14,QYMAX(R14)
         CH    R11,YMAX(R7)
         BC    4,Q01
         CH    R10,YMAX(R7)
         BC    4,Q2
Q3       MVI   0(R14),X'03'
         B     BXLE
Q2       MVI   0(R14),X'02'
         B     BXLE
Q01      CH    R12,YMAX(R7)
```

```
         BC    4,Q0
Q1       MVI   0(R14),X'01'
         B     BXLE
Q0       MVI   0(R14),X'00'
BXLE     BXLE  R7,R8,ALF
         BEXIT EX0
         END
```

RAZE

```
*FUNCTION
*
*INCREASES THE Y COORDINATE OF THE CHARACTER CENTER BY (NORMAL CHAR-
*ACTER HEIGHT/2) RASTERS SO THAT A CHARACTER WHICH STRADDLES A LINE
*WILL BE DISPLAYED IN THE PROPER POSITION.
*
*
*
*CALL
*        RCS   RAZEA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST  .
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R8,R15
*
*
         USING XR6,R6
EX0      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    26H
         DS    20C
         DS    1H
HEIGHT   DS    1H
         DS    2F
         DS    1H
         DS    2C
         DS    3H
         DS    56C
         DS    21H
CENT     DS    1F
```

```
RAZE      BOX
          BEXIT EXO
          L     R8,CENT
          LH    R15,HEIGHT                  NORMAL CHAR HEIGHT
          SRL   R15,1
          AR    R8,R15
          ST    R8,CENT
          BEXIT EXO
          END
```

RELM

```
*FUNCTION
*
*UPCATES THE NO. AND POSITION OF RELATIVE  Y MAXIMA AND Y MINIMA.
*A STARTING POINT CAN BE A MAX OR MIN, AN ENDING POINT CANNOT
*
*
*
*CALL
*         RCS   RELMA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7,R8
*
*
          USING XR6,R6
          REGS
EXO       EQU   0
C6        DSECT
XR6       DS    0F
          DS    3F
          CS    2H
XT        DS    1H
YT        DS    1H
CX        CS    1H
DY        DS    1H
          DS    3H
          CS    17H
          DS    20C
          DS    3F
          DS    1H
```

```
         DS    2C
         DS    2H
DEL      DS    1H
         DS    56C
         DS    21H
         DS    1F
         DS    6C
         DS    1H
         DS    1F
         DS    20C
         DS    19H
PYMAX    DS    1H
PYMIN    DS    1H
NYMAX    DS    1H
NYMIN    DS    1H
YMAX     DS    10H
YMIN     EQU   YMAX+10
QYMAX    DS    10C
QYMIN    EQU   QYMAX+5
PYMXX    DS    1H
PYMNX    DS    1H
YMAXX    DS    10H
YMINX    EQU   YMAXX+10
RELM     BOX
         LH    R7,YT
         CH    R7,PYMAX
         BNH   NO
         STH   R7,PYMAX
         MVC   PYMXX(2),XT
*UPWARD STYLUS MOTION
PMIN     CLI   QYMIN,X'01'
         BNE   EXIT
*A MAX HAS OCCURRED PREVIOUSLY
         LH    R7,YT
         LH    R8,PYMIN
         SR    R7,R8
         LPR   R7,R7                   MAG(YT-PYMIN)
         LH    R8,DEL
         SLL   R8,1                    2*THINNING DISTANCE
         CR    R7,R8
         BNH   EXIT
*A MINIMUM DETECTED
         MVI   QYMIN,X'00'
         MVI   QYMAX,X'01'
         MVC   PYMAX(2),YT
         MVC   PYMXX(2),XT
         LH    R7,NYMIN
         LA    R7,1(R7)
         LA    R8,5
         CR    R7,R8
         BNH   NXOK
         SR    R7,R7
NXOK     STH   R7,NYMIN
         BCTR  R7,0
         SLL   R7,1
         LH    R8,PYMIN
         STH   R8,YMIN(R7)
         LH    R8,PYMNX
         STH   R8,YMINX(R7)
         B     EXIT
NO       CH    R7,PYMIN
         BNL   PMXN
         STH   R7,PYMIN
         MVC   PYMNX(2),XT
         B     PMAX
PMXN     LH    R7,DY
         LTR   R7,R7
         BP    PMIN
*DOWNWARD STYLUS MOTION
PMAX     CLI   QYMAX,X'01'
         BNE   EXIT
*A MIN   HAS OCCURRED PREVIOUSLY
         LH    R7,YT
         LH    R8,PYMAX
         SR    R7,R8
         LPR   R7,R7                   MAG(YT-PYMAX)
         LH    R8,DEL
         SLL   R8,1                    2*THINNING DISTANCE
         CR    R7,R8
         BNH   EXIT
*A MAXIMUM DETECTED
         MVI   QYMAX,X'00'
         MVI   QYMIN,X'01'
         MVC   PYMIN(2),YT
         MVC   PYMNX(2),XT
         LH    R7,NYMAX
         LA    R7,1(R7)
         LA    R8,5
         CR    R7,R8
         BNH   NNOK
         SR    R7,R7
NNOK     STH   R7,NYMAX
         BCTR  R7,0
         SLL   R7,1
         LH    R8,PYMAX
         STH   R8,YMAX(R7)
         LH    R8,PYMXX
         STH   R8,YMAXX(R7)
EXIT     BEXIT EXO
         END
```

SMOOTH

```
*FUNCTION
*
*COMPUTES NEW AVERAGED DATA PT. X OR Y COORDINATE FROM NEW RAW DATA PT.
*COORD. AND PREV. AVERAGED DATA PT. COORD.
*NEW = 3/4 PREV + 1/4 RAW
*
*
*
*CALL
*         RCS   SMOOTHA,EEXIT
*
*
*
*INPUT REGISTERS
*
*C(R6) = PREV AVERAGED X OR Y COORD.
*C(R7) = NEW RAW X OR Y COORD.
*
*
*
*OUTPUT REGISTERS
*
*C(R6) = NEW AVERAGED X OR Y COORD.
*
*
*
*INTERNAL REGISTERS.  R8
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    OF
SMOOTH   BOX
         LR    R8,R6
         SRA   R8,2
         SR    R6,R8
         SRA   R7,2
         AR    R6,R7
         BEXIT EXO
         END
```

TCRNR

```
*FUNCTION
*
*DETECTS TIME-PAUSE CORNERS BASED ON NPTS, THE NO. OF RAW DATA POINTS
*WHICH HAVE OCCURRED SINCE THE LAST THINNED DATA POINT, AND UPDATES
*NTCUSP, THE NO. OF SUCH CORNERS
*INDEX CUSP=1 IS TIME-CORNER HAS JUST OCCURRED, OTHERWISE CUSP=0.
*
*
*
*CALL
*         RCS   TCRNRA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R8
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    23H
NT       DS    1H
NTC      DS    1H
         DS    1H
         DS    20C
         DS    3F
         DS    1H
         DS    1C
CUSP     DS    1C
         DS    1H
NPTS     DS    1H
         DS    1H
         DS    56C
         DS    21H
         DS    1F
         DS    6C
         DS    1H
         DS    1F
         DS    20C
         DS    17H
```

```
NTCUSP    DS     1H
PNPTS     DS     1H
TCRNR     BOX
*TIME CORNER DETECTOR
          LH     R8,NT
          LA     R8,1(0,R8)
          STH    R8,NT
          CLI    NT+1,X'02'
          BC     12,CUSPID
          LH     R8,PNPTS
          SLL    R8,2
          AH     R8,PNPTS
          AH     R8,PNPTS                    R8=6*PNPTS
          CH     R8,NPTS
          BC     10,CUSPID
          CLI    CUSP,X'00'
          BC     6,NOCUSP
*CUSP=0
          LH     R8,NTCUSP
          LA     R8,1(0,R8)
          STH    R8,NTCUSP
          MVI    CUSP,X'01'
          LH     R8,NT
          STH    R8,NTC
          B      NOCUSP
CUSPID    MVI    CUSP,X'00'
NOCUSP    LH     R8,NPTS
          CH     R8,PNPTS
          BC     10,NPTSO
          STH    R8,PNPTS
NPTSO     XC     NPTS(2),NPTS
          BEXIT EXO
          END
```

THIN

```
*FUNCTION
*
*DETERMINES IF THE CURRENT DATA PT. X OR Y COORDINATE IS FARTHER FROM
*THE PREV. THINNED DATA PT. X OR Y COORD. THAN A DISTANCE DELTA.
*
*
*
*CALL
*         RCS    THINA,EEXIT
*
```

```
*
*
*INPUT REGISTERS
*
*C(R6) = CURRENT COORD
*C(R7) = PREV THINNED COORD
*C(R8) = DELTA
*
*
*
*OUTPUT REGISTERS
*
*C(R7) = NEW THINNED COORD = CURRENT DATA PT COORD, IF SUFFICIENTLY FAR
*C(R7) = PREV THINNED COORD IF NOT FAR
*
*
*
*INTERNAL REGISTERS.  R8,R9
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
THIN     BOX
         LR    R9,R6
         SR    R9,R7         DIFF
         LPR   R9,R9         MDIFF
         SR    R9,R8
         BC    12,THIN1      EXIT IF MDIFF <,= DEL
         LR    R7,R6         T(J)=S(I) IF > DEL
THIN1    BEXIT EXO
         END
```

TURNER

```
*FUNCTION
*
*DETECTS 180 DEGREE CHANGE IN STYLUS DIRECTION THAT OCCURS AFTER A
*SINGLE THINNING DISTANCE
*IF SUCH A TURN IS DETECTED, TTURN+1 = 1 FOR CLOCKWISE TURN, TTURN+1 =2
*FOR COUNTERCLOCKWISE TURN, OTHERWISE TTURN+1 = 0.
*
*
*
```

```
*CALL
*        RCS   TURNERA,II1,EEXIT
*WHERE I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*
*
*
*INPUT REGISTERS
*
*C(R6) = I1
*C(R9) = ANGLE (AS ENCODED BY 'CHAREC')
*
*
*
*INTERNAL REGISTERS.  R7, R8
*
*
         USING XR6,R6
EXO      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    8H
PANG     DS    1H
PACANG   DS    1H
         DS    16H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    56C
         DS    21H
         DS    1F
         DS    6C
TTURN    DS    1H
TURNER   BOX
*ANG DO  ES NOT EQ PREV ANG
*TEST F  OR 180 DEG TURN
*DOES P  REV ANG=PREV ACCEPTED ANG?
         LH    R7,PACANG
         CH    R7,PANG
         BC    8,NOTURN
*NO
*DO ANG   ? PACANG DIFFER BY 2?
         SR    R7,R9
         LPR   R7,R7
         LA    R8,2
         CR    R7,R8
         BC    6,NOTURN
*YES
```

```
*IS DIR  ECTION OF TURN CLKWISE?
*OR COU  NTERCLOCKWISE?
         LR    R7,R9
         SH    R7,PANG
         LTR   R7,R7
         BC    2,CCTURN
*POSSIB  LY CLKWISE
*DOES P  ANG EQ 0?
         SR    R7,R7
         CH    R7,PANG
         BC    8,CCT1
CTURN    MVI   TTURN+1,X'01'
         BC    15,TURNX
*POSSIB  LY CCLKWISE
*DOES A  NG EQ 0?
CCTURN   SR    R7,R7
         CR    R7,R9
         BC    8,CTURN
CCT1     MVI   TTURN+1,X'02'
         BC    15,TURNX
*NOT A   180 DEG WITH SINGLE ANGLE
NOTURN   MVI   TTURN+1,X'00'
*EXIT
TURNX    BEXIT EXO
         END
```

TRAVEC

```
*FUNCTION
*
*COMPUTES VECTOR DIRECTION ( 1 OF 16) IF STYLUS HAS MOVED A DISTANCE
*GREATER THAN DELTA (2, 4, 6, OR 8 RASTERS).
*
*
*
*CALL
*        RCS   TRAVECA,EEXIT
*
*
*
*INPUT REGISTERS
*
*C(R7) = X COORD OF NEW DATA PT.
*C(R9) = Y COORD OF NEW DATA PT.
*C(R10) = X COORD OF END PT. OF CURRENT VECTOR TRACK
*C(R11) = Y COORD OF END PT. OF CURRENT VECTOR TRACK
```

```
*C(R15) = 1/2 DELTA
*
*
*
*OUTPUT REGISTERS
*
*IF STYLUS HAS MOVED X OR Y DISTANCE GREATER THAN DELTA
*   C(R0) = DIRECTION CODE (X'0'--X'F')
*   C(R10) = X END PT. OF UPDATED VECTOR TRACK
*   C(R11) = Y END PT. OF UPDATED VECTOR TRACK
*OTHERWISE
*   C(R0) = X'0'
*   C(R10), C(R11) NOT UPDATED
*
*
*
*INTERNAL REGISTERS R6, R8, R14
*
*
         USING XR6,R6
EX0      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
TRAVEC   BOX
         LA    R0,16  RAST/DIR CONSTANT
         SR    R14,R14      QUADRANT CODE
         SR    R7,R10       X(I) - X(L)
         BC    10,TRAV1
         LA    R14,4(0,R14) QUAD 2 OR 3
         LPR   R7,R7        ABS DX
TRAV1    SR    R9,R11       Y(I) - Y(L)
         BC    10,TRAV2
         LA    R14,8(0,R14) QUAD 3 OR 4
         LPR   R9,R9        ABS DY
TRAV2    LR    R8,R7
         SR    R6,R6
         LH    R7,TRAST
         MR    R6,R15
         LR    R6,R7
         LR    R7,R8
         CR    R7,R6
         BC    11,TRAV3
         CR    R9,R6
         BC    4,TRAV8
TRAV3    CR    R7,R9        ABS DX AND DY
         BC    8,TRAV4      EQUAL
         BC    4,TRAV5      DY > DX
         SLL   R9,2      DX > DY
         SR    R8,R8        4(ABS DY)
         DR    R8,R7        4(ABS DY) / ABS DX
         LA    R9,1(0,R9)   1/2 ROUND
         SRL   R9,1      RESULT/2
         BC    15,TRAV6
TRAV5    SLL   R7,2     4(ABS DX)
         SR    R6,R6
         DR    R6,R9        4(ABS DX) / ABS DY
         LA    R7,1(0,R7)   1/2 ROUND
         SRL   R7,1     RESULT /2
         LNR   R9,R7
         A     R9,TRAVK4
         BC    15,TRAV6
TRAV4    LA    R9,2
TRAV6    A     R9,TQUAD(R14)
         LPR   R14,R9
         CR    R14,R0
         BC    4,TRAV7
         SR    R14,R14
TRAV7    LR    R0,R14
         SLL   R14,1
         SR    R6,R6
         LH    R7,TXIN(R14)
         MR    R6,R15
         AR    R10,R7
         SR    R6,R6
         LH    R7,TYIN(R14)
         MR    R6,R15
         AR    R11,R7
TRAV8    BEXIT EX0
TRAVK4   DC    F'4'
TQUAD    DC    F'0'
         DC    F'-8'
         DC    F'-16'
         DC    F'8'
TXIN     DS    0H            TABLE FOR 2 RAST VEC
         DC    H'8'
         DC    H'8'
         DC    H'8'
         DC    H'4'
         DC    H'0'
         DC    H'-4'
         DC    H'-8'
         DC    H'-8'
         DC    H'-8'
         DC    H'-8'
         DC    H'-8'
         DC    H'-4'
         DC    H'0'
         DC    H'4'
         DC    H'8'
         DC    H'8'
TYIN     DS    0H        TABLE FOR 2 RAST VECTORS
```

```
         DC     H'0'
         DC     H'4'
         DC     H'8'
         DC     H'8'
         DC     H'8'
         DC     H'8'
         DC     H'8'
         DC     H'4'
         DC     H'0'
         DC     H'-4'
         DC     H'-8'
         DC     H'-8'
         DC     H'-8'
         DC     H'-8'
         DC     H'-8'
         DC     H'-4'
TRAST    DC     H'8'            RAST SIZE OF 2 RAST
         END
```

REC

REC Function

```
*'REC' PERFORMS A FEW SIMPLE TESTS, BUT MOSTLY ACTS AS A LINK BETWEEN
*'CHAREC' (WHICH CALCULATES A SET OF FEATURES) AND THE PROCEDURES
*('INTERP' AND OTHER RCS'S) WHICH TEST THESE FEATURES, OR BETWEEN
*'INTERP' (WHICH PERFORMS MOST OF THE TESTS) AND THE OTHER RCS'S.
*'REC' HAS AN ORDERED LIST OF THE FEATURES, AND IS GIVEN THE RELATIVE
*ADDRESS OF THE HEAD OF THE LIST.  IT RETURNS A CHARACTER CODE TO
*'CHAREC'.  THE ONLY PARAMETERS MODIFIED BY 'REC' AND ITS RCS'S ARE 'P'
*'PAD', AND (ONLY FOR COMMA AND SOME SCRIPT CHARACTERS) THE Y
*COORDINATE OF THE CHARACTER CENTER.
```

REC Call

```
*        INST  AREC,RECA,II1,II1,EEXIT
*WHERE AREC IS A LINKAGE BETWEEN CHAREC'S CONTEXT AND REC'S CONTEXT
*  RECA IS A LINK TO REC
*  I1 IS AT THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*  EXIT EXIT IS THE ONLY EXIT
*
*
```

REC Sequence of Information Processing

```
****TABLE RE-ENTRY****
*
*LIST OF 'INTERP' LABELS EQU'D TO CODES
*USED FOR ENTERING 'INTERP' RCS
*
****RETURNS****
*
*LIST OF BRANCHES TO 'REC' LABELS
*USED FOR RETURNING TO 'REC' FROM 'INTERP'
*
****INITIAL CODE****
*
*INITIALIZE
*IF PERIOD, SET R8, GO TO CALL INTERP
*IF NOT SINGLE STROKE, GO TO SET-UP TABLE RE-ENTRY
*IF CHAR IS NOT LARGE, CALL 'TILDT' TO TEST FOR TILDA
*   IF NOT TILDA, GO TO SET-UP TABLE RE-ENTRY
*   IF TILDA, GO TO EXIT
*IF CHAR IS LARGE, CALL 'SYMT' TO TEST FOR AND RECOGNIZE GEOMETRIC SYM.
*   IF NOT GEOMETRICAL SYMBOL, GO TO SET-UP TABLE RE-ENTRY
*   IF GEOMETRICAL SYMBOL, GO TO EXIT
*
****COMPUTATIONAL SUBROUTINES****
*
*CALL ON AN RCS TO MAKE A TEST
*   RETURN TO EXIT WITH A CHARACTER
*     OR TO IN-LINE CODE
*     OR TO SET-UP TABLE RE-ENTRY
*
****SET-UP TABLE RE-ENTRY****
*
*SET R8 TO ADDRESS OF TABLE RE-ENTRY LABEL
*GO TO CALL INTERP
*
****IN-LINE CODE****
*
*MAKE TESTS
*GO TO SOMEPLACE IN 'REC'
*
****CALL INTERP****
*
*STORE R8 IN CUSP
*SET UP R14,R15
*CALL 'INTERP'
*   IF VALID EXIT, ENTER RETURNS TABLE BASED ON INDEX = R8
*   IF ERROR EXIT, GO TO CALL INTERP WITH R8 = ADDRESS OF 'DON'T KNOW'
*    LABEL.
*
```

```
****EXIT****
*
*EXIT TO 'CHAREC'
```

REC Program Listing

```
         USING XR1,R1
         USING XR3,R3
         USING XRX,R6
         REGS
         SVCS

DSECT1   DSECT
XR1      DS     0F
REGS     DS     3F
BANK     DS     1F
INDEX    DS     1F
         DS     1F
EXIT     EQU    0
DSECT3   DSECT
XR3      DS     0F
SCRTCH   DS     1F                           SCRATCH
COND     DS     1F
DATA     DSECT
XRX      DS     0F
I1       DS     1F
PAD      DS     1F
CODE     DS     1F
XS       DS     1H
YS       DS     1H
XT       DS     1H
YT       DS     1H
DX       DS     1H
DY       DS     1H
MDX      DS     1H
MDY      DS     1H
PANG     DS     1H
PACANG   DS     1H
N        DS     1H
SN       DS     1H
PUP      DS     1H
INKIND   DS     1H
PQUAD    DS     1H
BR56     DS     1H
DXC      DS     1H
DYC      DS     1H
XRC      DS     1H
XLC      DS     1H
YTC      DS     1H
YBC      DS     1H
ASPR     DS     1H
NT       DS     1H
NTC      DS     1H
```

```
INKC     DS    1H
XYE      DS    10C
XYS      DS    10C
WIDTH    DS    1H
HEIGHT   DS    1H
         DS    2F
YCENT    DS    1H
PCHAR    DS    1C
CUSP     DS    1C
NCUSP    DS    1H
NPTS     DS    1H
DEL      DS    1H
P        DS    1C
CHAR     DS    1C
TEMP     DS    1C
TINK     DS    5C
XSP      DS    10C
YSP      DS    10C
XEP      DS    10C
YEP      DS    10C
ALXYJ    DS    8C
XL       DS    1H
YL       DS    1H
XLO      DS    1H
YLO      DS    1H
*AX3 THRU AX02 ARE USED AS NTCUSP,NYMAX,NYMIN, QYMAX, AND QYMIN BY REC
AX3      DS    1H
AX2      DS    1H
AX1      DS    1H
AX       DS    1H
AX23     DS    1H
AX12     DS    1H
AX01     DS    1H
AX02     DS    1H
NC       DS    1H
C        DS    1H
CYM      DS    1H
CXS      DS    1H
CYS      DS    1H
XRS      DS    1H
XLS      DS    1H
YTS      DS    1H
YBS      DS    1H
CENT     DS    1F
MVC      DS    6C
TTURN    DS    1H
TURN     DS    1F
XC       DS    10C
YC       DS    10C
D0       DS    1H
D1       DS    1H
```

```
D2       DS    1H
D3       DS    1H
D4       DS    1H
D5       DS    1H
D6       DS    1H
D7       DS    1H
*BEWARE, DATA BELOW D7 CANNOT BE REFERRED TO BY TABLE MACROS
D8       DS    1H
D9       DS    1H
D10      DS    1H
D11      DS    1H
D12      DS    1H
D13      DS    1H
D14      DS    1H
D15      DS    1H
DN       DS    1H
NTCUSP   EQU   AX3
NTCSP1   DS    1H
PNPTS    DS    1H
PYMAX    DS    1H
PYMIN    DS    1H
NYMAX    EQU   AX2
NYMX1    DS    1H
NYMIN    EQU   AX1
NYMN1    DS    1H
YMAX     DS    10H
YMIN     EQU   YMAX+10
QYMAX    EQU   AX
QYMIN    EQU   QYMAX+5
QYMX1    DS    10C
QYMN1    EQU   QYMX1+5
PYMXX    DS    1H
PYMNX    DS    1H
YMAXX    DS    10H
YMINX    EQU   YMAXX+10
*BEWARE, DATA BELOW D7 CANNOT BE REFERRED TO BY TABLE MACROS
XYSP     EQU   XYS-DATA                         XYS DSECT(R6)
XYEP     EQU   XYE-DATA                         XYE DSECT(R6)
*
*
****TABLE RE-ENTRY****
*
*
SPER     EQU   0
SXHBL    EQU   1
S4       EQU   2
SK       EQU   3
AAAA     EQU   4
KVXYM    EQU   5
PADEX    EQU   6
TPLUSM   EQU   7
```

```
SBM5      EQU   8
SJMU      EQU   9
SUMJU1    EQU   10
SM1       EQU   11
SXMSTR    EQU   12
SOMDQ8    EQU   13
SCPNU     EQU   14
RSB       EQU   15
RSC       EQU   16
RSE       EQU   17
RSF       EQU   18
RSG       EQU   19
RSI       EQU   20
RSJ       EQU   21
RSL       EQU   22
RSM       EQU   23
RSN       EQU   24
RSO       EQU   25
RSR       EQU   26
RSS       EQU   27
RSU       EQU   28
RSV       EQU   29
RSW       EQU   30
RSY       EQU   31
RSZ       EQU   32
SA        EQU   33
SG        EQU   34
SM        EQU   35
SNN       EQU   36
SP        EQU   37
SR        EQU   38
SU        EQU   39
SO        EQU   40
S8        EQU   41
SSTAR     EQU   42
SSCRUB    EQU   43
DK        EQU   44
RSA       EQU   45
SE        EQU   46
REC       PROCS CLEAR=3,CNTX=6,AUTO=2,PROLG=SINS,ID=8000021C
AHTEST    DC    V(AHSTR1)
KNYT      DC    V(KNYTST)
KNY1TA    DC    V(KNY1T)
KVXYTA    DC    V(KVXYT)
MWTA      DC    V(MWT)
PTST      DC    V(PSTEST)
SYMTA     DC    V(SYMT)
TILDTA    DC    V(TILDT)
TPXYA     DC    V(TPXY)
VERT      DC    V(VERTST)
VFI       DC    V(BFI)
```

```
VSDP     DC    V(BSDP)
VSMNW    DC    V(BSMNW)
VSRPRM   DC    V(BSRPRM)
VSSM     DC    V(BSSM)
VSVM     DC    V(BSVM)
VTEST1   DC    V(BTEST1)
VTEST3   DC    V(BTEST3)
VTERP    DC    V(INTERP)
VHITE    DC    V(BHITE)
VRAZE    DC    V(RAZE)
*
*
****RETURNS****
*
*
RETURNS  EQU   *
         BC    15,XAHSTR
         BC    15,XKNY
         BC    15,XFI
         BC    15,XKVXY
         BC    15,XMW
         BC    15,XMWIN
         BC    15,XMW1
         BC    15,XPOST
         BC    15,XRECD
         BC    15,XSDP
         BC    15,XSMNW
         BC    15,XSM1M
         BC    15,XSRPRM
         BC    15,XSSM
         BC    15,XSVM
         BC    15,XTEST1
         BC    15,XTEST3
         BC    15,XTPLUS
         BC    15,XSTRLC
         BC    15,XSALCS
         BC    15,XSG8LC
         BC    15,XSMLCN
         BC    15,XSCBOU
         BC    15,XSNLC
         BC    15,XSPLC
         BC    15,XSRLC
         BC    15,XS8LC
         BC    15,XSULC
         BC    15,XS4LC
         BC    15,XSCPEL
         BC    15,XSCPMW
         BC    15,XSCPYZ
         BC    15,XSCPBS
         BC    15,XS8VMN
         BC    15,XRAZE
         BC    15,XS8LCV
         BC    15,XSULC1
         BC    15,XS4MK1
         BC    15,XSELCA
*
*
****INITIAL CODE****
*
*
SINS     PROLG
         L     R6,BANK
*MOVE DATA USED BY TABLE MACROS ABOVE FF IN DATA BANK
         MVC   NTCUSP(2),NTCSP1
         MVC   NYMAX(2),NYMX1
         MVC   NYMIN(2),NYMN1
         MVC   QYMAX(10),QYMX1
         CLI   N+1,X'00'
         BC    7,SYMO
         LA    R8,SPER
         BC    15,START
SYMO     EQU   *
         CLI   SN+1,X'01'
         BC    7,REENTR
TILTST   EQU   *
         LH    R15,HEIGHT
         SLL   R15,1
         CH    R15,DYC
         BC    12,LARGE
         CH    R15,DXC
         BC    12,LARGE
*CHARAC  TER IS NOT LARGE
*TEST F  OR TILDA
         RCS   TILDTA,EREENTR,EXRECD
*POSSIB  LY A FLOW CHART SYMBOL
*IS N A  T LEAST 2?
LARGE    CLI   N+1,X'02'
         BC    4,REENTR
*RECOGN  IZE FLOW CHART SYMBOL
         RCS   SYMTA,EREENTR,EXRECD
*
*
****COMPUTATIONAL SUBROUTINES****
*
*
XAHSTR   RCS   AHTEST,EXRECD
XFI      EQU   *
         RCS   VFI,EXRECD
XKNY     RCS   KNYT,EXRECD
XKNY1    RCS   KNY1TA,EXRECD
XKVXY    RCS   KVXYTA,EXRECD
XMWIN    RCS   MWTA,EXRECD
```

```
XPOST     EQU    *
          RCS    PTST,EXRECD
XSDP      EQU    *
          RCS    VSDP,EXRECD
XSM1M     EQU    *
          RCS    VERT,EXSM1,EXKVXYM,EXPLUSM,EXPADEX
XSRPRM    EQU    *
          RCS    VSRPRM,EXRECD,EXSDP,EXPOST
XSSM      EQU    *
          RCS    VSSM,EXRECD
XSVM      EQU    *
          RCS    VSVM,EXRECD,EXSJMU,EXMW1,EXKNY1,EXSOMO,EXSMJU1
XTEST1    EQU    *
          RCS    VTEST1,EX8LCG,EXSSM
XTEST3    EQU    *
          RCS    VTEST3,EXRECD,EXSBM5
XTPLUS    RCS    TPXYA,EXRECD
XSCPEL    EQU    *
          RCS    VHITE,EXLEU,EXHLO
XSMLCN    EQU    *
          RCS    VHITE,EXSCPNU,EXSM
XSCPMW    EQU    *
          RCS    VHITE,EXLMW,EXSSCRB
XSALCS    EQU    *
          RCS    VHITE,EXRSS,EXSA
XSCPBS    EQU    *
          RCS    VHITE,EXRSS,EXRSB
XMLC      EQU    *
          RCS    VHITE,EXLMW,EXHMY
XSNLC     EQU    *
          RCS    VHITE,EXLOV,EXHBJN
XSMNW     EQU    *
          RCS    VSMNW,EXRECD,EXMLC,EXRAZE
XSRLC     EQU    *
          RCS    VHITE,EXRSN,EXSR
XSPLC     EQU    *
          RCS    VHITE,EXRSR,EXSPP
XSULC1    EQU    *
          RCS    VHITE,EXRSU,EXSU
XS4LC     EQU    *
          RCS    VHITE,EXRSE,EXRSL
XS8LC     EQU    *
          RCS    VHITE,EXLVO,EXS8
XSULC     EQU    *
          RCS    VHITE,EXRSN,EXHRU
XSTRLC    EQU    *
          RCS    VHITE,EXCS,EXSSTAR
XSBVMN    EQU    *
          RCS    VHITE,EXLMNV,EXHBL
XSCBOU    EQU    *
          RCS    VHITE,EXLOU,EXHBM
```

```
XSG8LC   EQU    *
         RCS    VHITE,EXRSO,EXSG8
XS8LCV   EQU    *
         RCS    VHITE,EXRSV,EXS8
XSELCA   EQU    *
         RCS    VHITE,EXRSA,EXSE
XRAZE    EQU    *
         RCS    VRAZE,EXRECD
*
*
****SET-UP TABLE RE-ENTRY****
*
*
REENTR   EQU    *
         L      R4,INDEX
         L      R7,0(R4)
         STC    R7,TEMP
         LA     R8,AAAA
         BC     15,START
XKVXYM   EQU    *
         LA     R8,KVXYM
         BC     15,START
XPADEX   EQU    *
         LA     R8,PADEX
         BC     15,START
XPLUSM   EQU    *
         LA     R8,TPLUSM
         BC     15,START
XSBM5    EQU    *
         LA     R8,SBM5
         B      START
XSJMU    EQU    *
         LA     R8,SJMU
         B      START
XSMJU1   EQU    *
         LA     R8,SUMJU1
         B      START
XSM1     EQU    *
         LA     R8,SM1
         BC     15,START
XSXMST   LA     R8,SXMSTR
         B      START
XSOMO    EQU    *
         LA     R8,SCMOQ8
         B      START
XHBL     LA     R8,SXHBL
         B      START
XSCPNU   LA     R8,SCPNU
         B      START
XRSA     LA     R8,RSA
         B      START
```

```
XRSB     LA    R8,RSB
         B     START
XRSC     LA    R8,RSC
         B     START
XRSE     LA    R8,RSE
         B     START
XRSF     LA    R8,RSF
         B     START
XRSG     LA    R8,RSG
         B     START
XRSI     LA    R8,RSI
         B     START
XRSJ     LA    R8,RSJ
         B     START
XRSL     LA    R8,RSL
         B     START
XRSM     LA    R8,RSM
         B     START
XRSN     LA    R8,RSN
         B     START
XRSO     LA    R8,RSO
         B     START
XRSR     LA    R8,RSR
         B     START
XRSS     LA    R8,RSS
         B     START
XRSU     LA    R8,RSU
         B     START
XRSV     LA    R8,RSV
         B     START
XRSW     LA    R8,RSW
         B     START
XRSY     LA    R8,RSY
         B     START
XRSZ     LA    R8,RSZ
         B     START
XSA      LA    R8,SA
         B     START
XSE      LA    R8,SE
         B     START
XSG      LA    R8,SG
         B     START
XSM      LA    R8,SM
         B     START
XSNN     LA    R8,SNN
         B     START
XSPP     LA    R8,SP
         B     START
XSR      LA    R8,SR
         B     START
XSU      LA    R8,SU
```

```
         B      START
XSO      LA     R8,SO
         B      START
XS8      LA     R8,S8
         B      START
XSSTAR   LA     R8,SSTAR
         B      START
XSSCRB   LA     R8,SSCRUB
         B      START
*
*
****IN-LINE CODE****
*
*
XMW      EQU    *
         LA     R13,3
         B      XMWIN
XMW1     EQU    *
         LA     R13,2
         B      XMWIN
XS4MK1   SR     R15,R15
         LA     R13,2
K4       LA     R7,0(R6,R15)
         TM     XYEP+1(R7),X'03'
         BC     1,XSKX
         BXLE   R15,R13,K4
         LA     R8,S4
         B      START
XSKX     TM     XYSP+1(R7),X'0F'
         BC     8,XSXMST
         LA     R8,SK
         B      START
XHBM     EQU    *
         TM     XYE+1,X'0C'
         BC     1,XSM
         B      XRSB
XLMW     TM     XYE+1,X'0C'
         BC     8,XRSW
         B      XRSM
XHMY     TM     XYE+1,X'0C'
         BC     12,XRSY
         B      XSM
XLOV     LH     R7,XRC
         SH     R7,XLC
         SRL    R7,2         1/4 CHAR WIDTH
         LH     R8,XEP
         SH     R8,YMAXX
         LPR    R8,R8
         CR     R8,R7
         BC     4,XRSO
         B      XRSV
```

```
XHBJN    TM    XYS+1,X'0C'
         BC    12,XRSF
         TM    XYE+1,X'0C'
         BC    5,XRSB
         B     XSNN
XHLO     TM    XYE+1,X'03'
         BC    8,XRSL
         B     XSO
XHRU     EQU   *
*U IF 2ND MAX IN RIGHT 1/2, OTHERWISE R
         LH    R8,DXC
         SRL   R8,1
         LH    R7,XRC
         SR    R7,R8
         CH    R7,YMAXX+2
         BC    2,XSR
         B     XSU
XSCPYZ   EQU   *
         LH    R7,YMINX+2
         CH    R7,YMAXX
         BC    4,XRSZ
         B     XRSY
XCS      EQU   *
*C IF 2ND OR 3RD ANGLE IS 0
         TM    CODE,X'30'
         BC    8,XRSC
         TM    CODE,X'0C'
         BC    8,XRSC
         B     XRSS
X8LCG    CLI   CODE,X'87'
         BC    8,XRSG
         B     XRECD
XLEU     CLI   N+1,X'C5'
         BC    2,XRSU
         B     XRSE
XLMNV    EQU   *
         CLI   N+1,X'05'
         BC    8,XNV
         BC    4,XRSE
         CLI   N+1,X'06'
         BC    2,XRSM
         B     XSCPNU
XNV      TM    XYE+1,X'08'
         BC    1,XSCPNU
         B     XRSV
XLOU     TM    XYE+1,X'08'
         BC    8,XRSO
         B     XRSU
XLVC     TM    CODE,X'08'
         BC    1,XRSO
         B     XRSV
```

```
XSG8     TM    XYE+1,X'OC'
         BC    8,XS8
         B     XSG
*
*
****CALL INTERP****
*
*
* THIS IS THE INTERPRETER        R8 IS THE 'INSTRUCTION COUNTER'
*                             COND CONTAINS THE 'CONDITION CODE'
*
START    EQU   *
         STC   R8,CUSP
         LA    R14,COND
         LA    R15,SCRTCH
         RCS   VTERP,EEXO,EEX1         CALL THE INTERPRETER
EXO      EQU   *
         ST    R8,SCRTCH
         SWTCH INDEX=SCRTCH,TABLE=RETURNS
EX1      EQU   *
         LA    R8,DK
         BC    15,START                SIGNAL NOT UNDERSTOOD
*
*
****EXIT****
*
*
XRECD    EQU   *
         EPLOG EXIT
         END
```

INTERP

INTERP Function

```
*'INTERP' PERFORMS SEQUENCES OF TESTS ON ENCODED 1-BYTE FEATURES
*THEREBY INCLUDING NEARLY ALL OF THE DECISION-MAKING TREE STRUCTURE.
*'INTERP' IS ENTERED VIA 'REC' AND CALLS RCS'S (WHICH PERFORM THE MORE
*COMPLICATED TESTS) VIA 'REC'.  A 'TABLE' MACRO (DESCRIBED BELOW) IS
*USED TO PERFORM THE TESTS.
```

INTERP Call

```
*
*         RCS   INTERPA,EVALIC,EERROR
* WHERE INTERPA IS A LINK TO INTERP
*   EXIT VALIC IS THE NCRMAL EXIT
*   EXIT ERROR IS THE ERROR EXIT
```

INTERP Sequence of Information Processing

```
****INTERPRETER****
*
*INTERPRETER FCR 'TABLE' MACRO
*
****TABLE EXITS****
*
*LIST OF 'REC' LABELS EQU'D TO CODES
*USED FCR RETURNING TC 'REC' ROUTINE
*
****TABLE TESTS****
*
*CALLS ON THE 'TABLE' MACRO TO PERFORM SEQUENCES OF TESTS ON (OR MOD-
*IFICATIONS OF) ENCODED 1-BYTE FEATURES.  THE CALL HAS THE FCLLOWING
*FCRM:
*LABEL   TABLE /OP1,P1,C1/,C11,L11,C12,L12,...,C1K,L1K,/OP2,P2,C2/,C21,X
*                  L21,C22,...
*WHERE CONTINUATION TO NEXT CARD IS INDICATED BY A NON-BLANK COLUMN 72
*   OPI IS AN ABBREVIATED OP CODE
*     TM = TEST UNDER MASK
*     MV = MOVE IMMEDIATE
*     NI = AND IMMEDIATE
*     CL = COMPARE LOGICAL IMMEDIATE
*     OI = OR IMMEDIATE
*     X2 = EXCLUSIVE OR IMMEDIATE
*     TR = TRANSLATE
*     SS = SWITCH
*     EX = EXIT FROM TABLE
*   IF CPI = TR
*      PI = THE TRANSLATION INDEX
*      CI = 00
*      CIJ = 0
*      LIJ = START OF A LIST OF DC'S
*   IF OPI = SS
*      PI = TEMP
*      CI = 00
*      CIJ = 0
*      LIJ = START CF LIST CF BRANCHES
*   IF CPI = EX
*      PI = A 'REC' LABEL
*      CI = 0
*      CIJ,LIJ ARE OMITTED
*   OTHERWISE
*      PI = THE FEATURE TO BE TESTED OR MODIFIED (ONLY 'P', 'PAD', OR
*           'CHAR' MAY BE MODIFIED)
*      CI = THE 2 CHARACTER 1-BYTE NUMBER WHICH PI IS TESTED AGAINST OR
*           MODIFIED BY
*      CIJ = THE CONDITION CODE UNDER WHICH THE SEQUENCE OF CONTROL
*           BRANCHES TO LABEL LIJ
*
****SET-UP CHARACTER CODE****
*
*MOVE CHARACTER CODE INTO 'CHAR'
*BRANCH TO THE SET OF ESCAPES
*
****PAD TABLE****
*
*LIST OF BRANCHES TO 'INTERP' LABELS
*USED FOR ENTERING 'INTERP' BASED ON VALUE OF 'PAD'
*
****4 DIRECTION TABLE****
*
*LIST OF BRANCHES TO 'INTERP' LABELS
*USED FOR ENTERING 'INTERP' BASED ON THE VALUES ON THE FIRST FOUR
*DIRECTIONS IN THE DIRECTION SEQUENCE AS ENCODED BY 'ANG4'
*
****SET OF ESCAPES****
*
*EXITS FROM 'INTERP' TO 'REC'
*
****ENTRY SWITCH****
*
*LIST OF BRANCHES TO 'INTERP' LABELS
*USED FOR ENTERING 'INTERP' FROM 'REC'
```

INTERP Program Listing

```
         USING XRX,R6
         REGS
TM       EQU   X'91'                 TEST UNDER MASK
MV       EQU   X'92'                 MOVE IMMEDIATE
NI       EQU   X'94'                 AND IMMEDIATE
CL       EQU   X'95'                 COMPARE LOGICAL IMMEDIATE
CI       EQU   X'96'                 OR IMMEDIATE
X2       EQU   X'97'                 EXCLUSIVE OR IMMEDIATE
TR       EQU   X'99'                 TRANSLATE
SS       EQU   X'9A'                 SWITCH
EX       EQU   X'9B'                 EXIT THE TABLE
DATA     DSECT
XRX      DS    0F
I1       DS    1F
PAD      DS    1F
CODE     DS    1F
XS       DS    1H
YS       DS    1H
```

```
XT       DS    1H
YT       DS    1H
DX       DS    1H
DY       DS    1H
MDX      DS    1H
MDY      DS    1H
PANG     DS    1H
PACANG   DS    1H
N        DS    1H
SN       DS    1H
PUP      DS    1H
INKIND   DS    1H
PQUAD    DS    1H
BR56     DS    1H
DXC      DS    1H
DYC      DS    1H
XRC      DS    1H
XLC      DS    1H
YTC      DS    1H
YBC      DS    1H
ASPR     DS    1H
NT       DS    1H
NTC      DS    1H
INKC     DS    1H
XYE      DS    10C
XYS      DS    10C
WIDTH    DS    1H
HEIGHT   DS    1H
         DS    2F
YCENT    DS    1H
PCHAR    DS    1C
CUSP     DS    1C
NCUSP    DS    1H
NPTS     DS    1H
DEL      DS    1H
P        DS    1C
CHAR     DS    1C
TEMP     DS    1C
TINK     DS    5C
XSP      DS    10C
YSP      DS    10C
XEP      DS    10C
YEP      DS    10C
ALXYJ    DS    8C
XL       DS    1H
YL       DS    1H
XLO      DS    1H
YLO      DS    1H
*AX3 THRU AX02 ARE USED AS NTCUSP, ETC. BY REC
AX3      DS    1H
AX2      DS    1H
```

```
AX1      DS    1H
AX       DS    1H
AX23     DS    1H
AX12     DS    1H
AX01     DS    1H
AX02     DS    1H
NC       DS    1H
C        DS    1H
DYM      DS    1H
DXS      DS    1H
DYS      DS    1H
XRS      DS    1H
XLS      DS    1H
YTS      DS    1H
YBS      DS    1H
CENT     DS    1F
MVC      DS    6C
TTURN    DS    1H
TURN     DS    1F
XC       DS    10C
YC       DS    10C
D0       DS    1H
D1       DS    1H
D2       DS    1H
D3       DS    1H
D4       DS    1H
D5       DS    1H
D6       DS    1H
D7       DS    1H
*BEWARE, DATA BELOW D7 CANNOT BE REFERRED TO BY TABLE MACROS
D8       DS    1H
D9       DS    1H
D10      DS    1H
D11      DS    1H
D12      DS    1H
D13      DS    1H
D14      DS    1H
D15      DS    1H
DN       DS    1H
NTCUSP   EQU   AX3
NTCSP1   DS    1H
PNPTS    DS    1H
PYMAX    DS    1H
PYMIN    DS    1H
NYMAX    EQU   AX2
NYMX1    DS    1H
NYMIN    EQU   AX1
NYMN1    DS    1H
YMAX     DS    10H
YMIN     EQU   YMAX+1C
QYMAX    EQU   AX
```

```
QYMX1    DS    10C
QYMIN    EQU   QYMAX+5
PYMXX    DS    1H
PYMNX    DS    1H
YMAXX    DS    10H
YMINX    EQU   YMAXX+10
*BEWARE, DATA BELOW D7 CANNOT BE REFERRED TO BY TABLE MACROS
XYSP     EQU   XYS-DATA                XYS DSECT(R6)
XYEP     EQU   XYE-DATA                XYE DSECT(R6)
EX0      EQU   0
EX1      EQU   4
*
*
****INTERPRETER****
*
*
INTERP   BOX
START    EQU   *                       ADVANCE
         LA    R7,BASE
         LA    R8,GPSW                 GENERAL PURPOSE SWITCH
         MVI   0(R14),X'00'            CLEAR THE CONDITION CODE
AGAIN    EQU   *
         CLI   0(R8),X'90'             COMMAND
         BC    4,BRANCH                MUST BE A BRANCH
         CLI   0(R8),X'9F'
         BC    2,BRANCH
MAGIC    EQU   *
         CLI   0(R8),X'98'             STANDARD COMMAND
         BC    2,T99
COMM     EQU   *
         MVC   0(2,R15),0(R8)
         SR    R9,R9
         IC    R9,2(R8)
         LA    R9,DATA(R9)             GET THE DATA
         MVC   2(2,R15),OPER
         EX    0,0(R15)
         LA    R8,3(R8)
         BAL   R10,COMM1
COMM1    EQU   *
         ST    R10,0(R14)
         BC    15,AGAIN
T99      EQU   *
         CLI   0(R8),X'9F'             REALLY A BRANCH
         BC    2,BRANCH
         CLI   0(R8),X'99'
         BC    7,T9A
         MVC   0(2,R15),3(R8)          MUST BE A TRANSLATE
         LH    R9,0(R15)
         LA    R9,0(R7,R9)             FIND THE TABLE
         SR    R10,R10
         IC    R10,2(R8)
         LA     R10,DATA(R10)           FIND THE DATA
         MVC    TEMP(1),0(R10)
         TR     TEMP(1),0(R9)
         LA     R8,5(R8)                ADVANCE THE IC
         BC     15,AGAIN
T9A      EQU    *
         CLI    0(R8),X'9A'
         BC     7,T9B
         SR     R9,R9                   MUST BE A SWITCH
         IC     R9,2(R8)
         LA     R10,DATA(R9)
         IC     R9,0(R10)
         SLL    R9,1
         MVC    0(2,R15),3(R8)
         LH     R10,0(R15)
         LA     R10,0(R7,R10)           GET TABLE
         LA     R10,0(R9,R10)           GET T ABLE ENTRY
         MVC    2(2,R15),0(R10)
         BC     15,AGREE
T9B      EQU    *
         CLI    0(R8),X'9B'
         BC     7,ERROR
         MVI    0(R15),X'00'
         MVC    1(1,R15),1(R8)          MUST BE AN EXIT
         LH     R8,0(R15)
         BEXIT  EX0
BRANCH   EQU    *                       MUST BE A BRANCH
         MVC    0(1,R15),0(R14)
         NI     0(R15),X'30'
         MVC    2(2,R15),0(R8)
         MVC    1(1,R15),2(R15)
         NI     1(R15),X'F0'
         SR     R10,R10
         IC     R10,0(R15)
         SRL    R10,2
         LA     R10,TESTM(R10)
         EX     0,0(R10)
         BC     1,AGREE
         LA     R8,2(R8)
         BC     15,AGAIN
AGREE    EQU    *
         NI     2(R15),X'0F'
         LH     R9,2(R15)
         LA     R8,0(R7,R9)
         BC     15,AGAIN
ERROR    EQU    *
         BEXIT  EX1
TESTM    EQU    *
         TM     1(R15),X'80'
         TM     1(R15),X'40'
         TM     1(R15),X'20'
         TM    1(R15),X'10'
OPER     DC    X'9C00'
*
*
****TABLE EXITS****
*
*
* TABLE EXITS
XAHSTR   EQU   0
XKNY     EQU   1
XFI      EQU   2
XKVXY    EQU   3
XMW      EQU   4
XMWIN    EQU   5
XMW1     EQU   6
XPOST    EQU   7
XRECD    EQU   8
XSDP     EQU   9
XSMNW    EQU   10
XSM1M    EQU   11
XSRPRM   EQU   12
XSSM     EQU   13
XSVM     EQU   14
XTEST1   EQU   15
XTEST3   EQU   16
XTPLUS   EQU   17
XSTRLC   EQU   18
XSALCS   EQU   19
XSG8LC   EQU   20
XSMLCN   EQU   21
XSCBOU   EQU   22
XSNLC    EQU   23
XSPLC    EQU   24
XSRLC    EQU   25
XS8LC    EQU   26
XSULC    EQU   27
XS4LC    EQU   28
XSCPEL   EQU   29
XSCPMW   EQU   30
XSCPYZ   EQU   31
XSCP8S   EQU   32
XSBVMN   EQU   33
XRAZE    EQU   34
XS8LCV   EQU   35
XSULC1   EQU   36
XS4MK1   EQU   37
XSELCA   EQU   38
*
*
****TABLE TESTS****
*
```

```
*
BASE      EQU   *
AHSTR     TABLE /MV,PAD+3,3A/,15,AHSTRX
BR        TABLE /TM,CODE+1,80/,1,TEST3,/TM,CODE+1,10/,8,TEST3,/CL,N+1,05X
                /,8,SW,15,SM
FIME      TABLE /MV,P,00/,15,FIME1
FIME1     TABLE /CL,P,C2/,8,SE,/CL,P,01/,8,SPOUND,/MV,PAD+3,23/,15,FI
G6ETST    TABLE /TR,P,C0/,0,PBB,/SS,TEMP,00/,0,PBBX
PBB       DS    0H
          DC    X'03'
          DC    2X'CC'
          DC    2X'03'
          DC    3X'02'
          DC    4X'03'
PBBX      TABLE 15,OQ
          TABLE 15,SQ
          TABLE 15,S8
          TABLE 15,SG6X
KNYM      TABLE /MV,P,00/
KNYM1     TABLE /CL,P,C1/,8,MW,/MV,PAD+3,24/,15,KNY
KVXYM     TABLE /CL,P,C1/,8,KNYM,/CL,P,02/,8,AHSTR,/MV,PAD+3,C6/,/MV,P,0X
                8/,15,KVXY
LPRSLA    TABLE /CL,XYE+1,0F/,8,SSLASH,15,SLPAR
MK        TABLE /MV,P,C0/,/TM,XYS+3,02/,1,SM,15,SK
*P IF SECOND STROKE IS NOT SINGLE ANGLE OR DOUBLE ANGLE
CQ        TABLE /CL,N+1,02/,2,SP,/TM,XYS+3,0C/,5,SQ,/TM,XYS+3,03/,1,SQ,1X
                5,SO
PADEX     TABLE /SS,PAD+3,00/,0,PADT
PARSLA    TABLE /CL,XYS+1,00/,8,LPRSLA,/TM,XYS+1,02/,8,SLPAR,1,SRPAR
PGTR2     TABLE /MV,P,C2/,15,PADEX
TEST5     TABLE /MV,PAD+3,1E/,15,SVM
TPLUSM    TABLE /CL,P,C1/,8,AHSTR,/CL,P,02/,8,FIME,/MV,PAD+3,36/,/MV,P,0X
                A/,15,TPLUS                                             36
XMK       TABLE /MV,P,C0/,15,XMK1
XMK1      TABLE /CL,P,C1/,8,SK,/CL,P,02/,8,AHSTR,/MV,PAD+3,18/,/TM,XYS+1X
                ,02/,8,KVXY,/TM,XYS+3,02/,8,KVXY,/TM,XYE+3,02/,8,SR,/TM,X
                XYE+3,CC/,1,SD,15,SP
          EJECT
SASTAR    TABLE /TM,XYE+1,0C/,12,SALC,/EX,XSTRLC,0/
SALC      TABLE /TM,XYS+1,0C/,12,RSF,/TM,XYE+1,0C/,8,RSV,/TM,CODE,08/,1,X
                SALCS,/TM,CODE,04/,8,SCPBS,/TM,CODE,02/,1,SALCS,15,SCPBS
SALCF     TABLE /TM,XYS+1,0C/,1,SA,/MV,CHAR,86/,15,RECD
SALCS     TABLE /EX,XSALCS,0/
SAMSTR    TABLE /MV,P,C0/,15,SAMST1
SAMST1    TABLE /CL,P,C1/,8,SSTAR,/MV,PAD+3,15/,15,SA                   15
SA7       TABLE /CL,P,C2/,8,SA,/MV,PAD+3,37/,15,S7
SBARM     TABLE /CL,P,C2/,8,SETEQM,2,PGTR2,/CL,P,01/,8,STTPLS,/CL,SN+1,0X
                1/,2,PGTR2,/MV,P,02/,/CL,CODE,00/,8,SMINUS,/CL,ASPR,02/,X
                10,SSLASH,5,SMINUS
SBARMK    TABLE /CL,P,C1/,8,S4MK,/CL,P,02/,8,SETEQM,2,PGTR2,/MV,PAD+3,0DX
                /,15,SCRKRT
```

```
SBDPR     TABLE /TR,BR56+1,00/,0,II,/SS,TEMP,00/,0,III
II        DS    0H
          DC    X'00'
          DC    4X'00'
          DC    X'01'
          DC    4X'00'
          DC    X'01'
          DC    4X'00'
          DC    X'01'
          DC    X'02'
SBDPR1    TABLE /TR,BR56+1,00/,0,KK,/SS,TEMP,00/,0,KKK
KK        DS    0H
          DC    X'03'
          DC    X'01'
          DC    X'02'
          DC    2X'04'
          DC    X'00'
          DC    X'01'
          DC    X'04'
          DC    4X'00'
          DC    X'03'
          DC    X'01'
          DC    X'02'
          DC    X'03'
          DC    X'00'
KKK       TABLE 15,SDP
          TABLE 15,DK
          TABLE 15,SB
          TABLE 15,TEST3
          TABLE 15,SBR1
III       TABLE 15,TEST3
          TABLE 15,SDP
          TABLE 15,SPRMA
SBM5      TABLE /MV,P,00/,15,SBM51
SBM51     TABLE /CL,P,02/,8,S5,/MV,PAD+3,26/,15,SB
SBR1      TABLE /CL,N+1,06/,12,SR,/TM,CODE+1,0C/,12,SB,/CL,N+1,07/,8,SR,X
                15,SB
SCG       TABLE /CL,N+1,05/,2,SG,12,SCLC
SCLC      TABLE /CL,QYMIN,03/,8,RSD,15,SCC
SCLBRC    TABLE /CL,NTCUSP+1,01/,10,SLBRAC,/CL,ASPR+1,05/,2,SLBRAC,15,SCX
                C
SCMEG     TABLE /CL,P,01/,8,SK,/CL,P,02/,8,SE,/CL,P,03/,8,SG,/MV,PAD+3,1X
                6/,/MV,P,05/,/CL,NCUSP+1,01/,2,SLBRAC,8,SCLBRC,/CL,ASPR+X
                1,08/,2,SLPAR,15,SCC
SCMG      TABLE /TR,P,00/,0,PAA,/SS,TEMP,00/,0,PAAA
PAA       DS    0H
          DC    2X'02'
          DC    2X'00'
          DC    X'02'
          DC    3X'01'
          DC    4X'02'
```

```
PAAA     TABLE 15,SG
         TABLE 15,S8
         TABLE 15,SCMG1
SCMG1    TABLE /MV,PAD+3,05/,/MV,P,05/,15,SCC                        05
SCOM     TABLE /TM,XYE+1,0C/,8,SOMOQ8,5,SCMG
SCOMAM   TABLE /CL,PAD+3,15/,8,SAMST1,/CL,P,01/,8,SXMSTR,/CL,P,02/,8,SAX
               MSTR,/CL,P,0A/,8,SSTAR,/MV,PAD+3,14/,15,SKARAT        14
SCRKRT   TABLE /CL,NTCUSP+1,01/,4,SCC,15,SRKRT
SDMH     TABLE /CL,P,01/,8,SH,/MV,PAD+3,22/,15,SD
SEG06M   TABLE /CL,PAD+3,09/,8,SOMOQ8,/CL,PAD+3,21/,8,OQ,/CL,PAD+3,0A/,X
               8,G6ETST,/TM,XYE+1,08/,8,SOMOQ8,15,G6ETST             09
SETEQ    TABLE /MV,PAD+3,07/,/MV,P,08/,15,SEQL                       07
SETEQM   TABLE /CL,PAD+3,07/,8,SETXX,/MV,P,00/,15,SETXX
SETXX    TABLE /CL,P,02/,8,STPE,/CL,P,01/,8,FIME,/TM,XYS+1,08/,1,SETEQ,X
               /TM,XYE+1,0C/,12,SETEQ,/MV,PAD+3,06/,/MV,P,11/,15,SX
SET1AK   TABLE /MV,PAD+3,19/,/MV,P,09/,15,SK                         19
SEQ      TABLE /CL,N+1,04/,2,RSQ,15,SE
SFE      TABLE /CL,PAD+3,20/,8,SFME1,/CL,PAD+3,1F/,8,SFME,/CL,P,08/,8,SX
               E,/CL,P,07/,2,SFE1,/CL,P,05/,10,OQ,/CL,P,01/,8,STPK,/CL,X
               P,02/,8,SFME,15,SFE1
SFE1     TABLE /MV,PAD+3,1F/,15,LPRSLA                               1F
SFME     TABLE /MV,P,CC/,15,SFME1
SFME1    TABLE /CL,P,02/,8,SE,/MV,PAD+3,20/,/CL,XYE+1,0C/,8,SXMSTR,/CL,X
               XYE+3,CC/,8,SXMSTR,/CL,XYE+1,0D/,8,SXMSTR,/CL,XYE+3,0D/,X
               8,SXMSTR,/TM,XYE+3,02/,1,SY,15,SF
SGS      TABLE /CL,N+1,04/,12,S65,/TM,CODE+1,C0/,8,SG8,4,SSM,/TM,CODE+1X
               ,30/,5,SEG06M,/EX,XSELCA,0/
SGSCRB   TABLE /CL,N+1,04/,2,SSCRUB,12,SG8
SGS06M   TABLE /TM,TURN,08/,1,SEG06M,12,SSM
SG06M    TABLE /TR,BR56+1,00/,0,FF,/SS,TEMP,00/,0,FFF
FF       DS    0H
         DC    4X'02'
         DC    4X'01'
         DC    4X'00'
         DC    X'03'
         DC    3X'00'
         DC    X'00'
FFF      TABLE 15,SEG06M
         TABLE 15,S8
         TABLE 15,SG8
         TABLE 15,RSD
SG069M   TABLE /TR,BR56+1,00/,0,EE,/SS,TEMP,00/,0,EEEX
EE       DS    0H
         DC    9X'02'
         DC    X'03'
         DC    2X'04'
         DC    4X'01'
         DC    X'00'
EEEX     TABLE 15,SCOM
         TABLE 15,S9MG
         TABLE 15,SG8
         TABLE 15,S8
         TABLE 15,SEG06M
SG6X     TABLE /MV,PAD+3,0A/,/MV,P,06/,/CL,NTCUSP+1,01/,10,SG,/TM,XYE+1X
               ,02/,1,S6,/TM,XYE+1,01/,8,SG,/TM,XYE+1,0C/,1,S6,15,SG
SG8      TABLE /TM,XYE+1,0C/,5,SG,/EX,XSG8LC,0/
SG81     TABLE /TM,XYE+1,0C/,1,SG,15,S8
SJMU     TABLE /MV,P,00/,15,SUMXX
SUMXX    TABLE /CL,P,02/,8,SU,/MV,PAD+3,27/,15,SJ
SK5      TABLE /CL,P,01/,8,SK,/MV,PAD+3,28/,15,S5
SLKRTM   TABLE /MV,PAD+3,10/,/CL,P,00/,8,SLKRT,2,SRPRM
SLMEK4   TABLE /TR,P,00/,0,PEE,/SS,TEMP,00/,0,PEEE
PEE      DS    0H
         DC    X'03'
         DC    X'00'
         DC    X'05'
         DC    3X'03'
         DC    X'04'
         DC    X'03'
         DC    X'01'
         DC    2X'03'
         DC    X'02'
PEEE     TABLE 15,S4Y
         TABLE 15,STPE
         TABLE 15,SK
         TABLE 15,SLX
         TABLE 15,SQ
         TABLE 15,SXME
SLX      TABLE /MV,PAD+3,1A/,/CL,ASPR+1,08/,2,SLPAR,12,SL                    1A
SMC      TABLE /TR,BR56+1,00/,0,DD,/SS,TEMP,00/,0,DDD
DD       DS    0H
         DC    4X'02'
         DC    X'00'
         DC    X'01'
         DC    X'03'
         DC    X'04'
         DC    X'06'
         DC    X'02'
         DC    X'05'
         DC    X'06'
         DC    3X'02'
         DC    X'04'
         DC    X'01'
DDD      TABLE 15,SG
         TABLE 15,SCMG
         TABLE 15,SSM
         TABLE 15,SEG06M
         TABLE 15,S9MG
         TABLE 15,S6S
         TABLE 15,SE
SMLC     TABLE /CL,N+1,05/,2,SCPMWK,/TM,XYS+1,08/,8,SCPPYZ,/CL,QYMAX+1,X
               00/,2,SCPBH,/EX,XSMLCN,0/
```

```
SM1       TABLE /CL,ASPR+1,20/,2,S1,/CL,ASPR+1,0C/,12,PARSLA,/TM,XYS+1,0X
                2/,1,S1RPAR,/TM,XYE+1,02/,1,S1,8,SLPAR,15,S1RPAR
SNMA      TABLE /CL,P,C2/,8,SA,/CL,P,01/,8,RSX,/MV,PAD+3,29/,/TM,CODE,0CX
                /,1,SNLC,4,SNLC1,/TM,XYS+1,0C/,12,S2LCY,/EX,XSCBCU,0/
SNLC      TABLE /EX,XSNLC,0/
SNLC1     TABLE /TM,CODE,08/,1,SNLC,/TM,XYS+1,0C/,1,SNLC,/TM,XYE+1,08/,1X
                ,S2,15,SNLC
SPRMA     TABLE /MV,PAC+3,0C/,/CL,P,01/,8,SM,/CL,P,02/,8,SA,/TM,XYE+1,0CX
                /,12,SPLC,/TM,XYE+1,02/,1,SD,15,SRLC
SPLC      TABLE /EX,XSPLC,0/
SRLC      TABLE /CL,QYMAX+1,00/,8,SRLCX,/CL,N+1,05/,2,RSK,15,RSH
SRPRMJ    TABLE /CL,P,C2/,8,SJ,/CL,P,06/,8,SC,/MV,PAD+3,2A/,15,SRPAR
SS589M    TABLE /TR,BR56+1,00/,C,GG,/SS,TEMP,00/,0,GGG
GG        DS    0H
          DC    X'05'
          DC    2X'06'
          DC    X'01'
          DC    X'07'
          DC    X'04'
          DC    2X'01'
          DC    X'03'
          DC    X'04'
          DC    X'02'
          DC    X'01'
          DC    X'03'
          DC    X'04'
          DC    X'01'
          DC    X'02'
          DC    X'00'
GGG       TABLE 15,S9MG
          TABLE 15,DK
          TABLE 15,SSM
          TABLE 15,S8
          TABLE 15,TEST1
          TABLE 15,SE
          TABLE 15,RSQ
          TABLE 15,RSG
SS8M      TABLE /TR,BR56+1,00/,0,HH,/SS,TEMP,00/,0,HHH
HH        DS    0H
          DC    5X'01'
          DC    X'03'
          DC    4X'01'
          DC    X'02'
          DC    4X'01'
          DC    X'02'
          DC    X'00'
HHH       TABLE 15,SSM
          TABLE 15,S8
          TABLE 15,DK
          TABLE 15,TEST1
STPA      TABLE /MV,P,C0/,/MV,PAD+3,2B/,15,SALCF
```

```
STPE      TABLE /MV,P,00/,/MV,PAD+3,2C/,15,SE
STPH8     TABLE /CL,P,01/,8,SH,/CL,P,02/,8,SF,/MV,PAD+3,2D/,15,S8LC
S8LC      TABLE /EX,XS8LC,0/
STPK      TABLE /CL,P,01/,8,KVXY,15,STPK1
STPK1     TABLE /MV,P,00/,/MV,PAD+3,2E/,15,SK
STPJ      TABLE /MV,PAD+3,2F/,15,SJ
STPM      TABLE /CL,P,01/,8,SM,/MV,PAD+3,30/,15,SYLC
SYLC      TABLE /CL,N+1,05/,2,RSM,/CL,QYMIN,03/,8,RSN,15,SY
STP5      TABLE /CL,PAD+3,03/,8,S5,/CL,P,02/,8,S5,/MV,PAD+3,03/,/TM,XYE+X
                1,08/,8,S8,/CL,CODE,CB/,6,S5,/TM,TURN,04/,8,S6,15,S5
STP6      TABLE /MV,PAD+3,02/,/CL,P,01/,8,S0,/CL,P,02/,8,S5,/CL,P,06/,8,X
                S8,/MV,P,06/,15,S6
STTPLS    TABLE /MV,P,00/,15,TPLUSM
SUMAM     TABLE /MV,PAD+3,0F/,/CL,P,01/,8,MK,/CL,P,02/,8,SA,/CL,N+1,05/,X
                2,SW,/CL,CODE,C7/,8,SULC1,15,SULC
SULC      TABLE /CL,QYMAX+1,00/,2,RSH,/TM,XYE+1,0C/,12,RSR,/EX,XSULC,0/
SULC1     TABLE /CL,QYMIN,03/,4,RSY,/EX,XSULC1,0/
SUMJU     TABLE /CL,P,02/,8,SJMU,/CL,P,01/,8,SY,/CL,P,07/,8,S8,/MV,TEMP,X
                00/,15,TEST5
SUMJU1    TABLE /MV,P,07/,/MV,PAD+3,31/,15,SU
SXHBL     TABLE /CL,N+1,04/,8,RSL,/CL,NYMAX+1,01/,12,RSB,/CL,N+1,07/,2,RX
                SK,15,RSH
SXME      TABLE /MV,PAD+3,1B/,/MV,P,00/,/CL,CODE,00/,8,SLBRAC,15,SX    1B
SXMSTR    TABLE /MV,P,00/,15,SXMST1
SXMST1    TABLE /CL,P,02/,8,SSTAR,/MV,PAD+3,32/,15,SX                  32
          EJECT
SOMOQ8    TABLE /TR,P,00/,0,PBB,/SS,TEMP,00/,0,PBBB
PBBB      TABLE 15,OQ
          TABLE 15,SQ
          TABLE 15,S8
          TABLE 15,SOX
SOX       TABLE /MV,PAD+3,09/,/MV,P,06/,/TM,CODE,C0/,1,SOD,15,SO
SOD       TABLE /CL,NTCUSP+1,01/,10,SD,15,SO
SO23MB    TABLE /TM,XYE+1,08/,1,S23MB,15,SOMOQ8
SO9       TABLE /TM,XYE+1,0C/,1,S9,15,SOMOQ8
SO9M      TABLE /CL,N+1,05/,2,SOMOQ8,15,S9LC1
S1MAK     TABLE /TR,P,00/,0,PCC,/SS,TEMP,00/,0,PCCC
PCC       DS    0H
          DC    X'02'
          DC    X'00'
          DC    X'01'
          DC    X'03'
          DC    7X'00'
          DC    X'03'
PCCC      TABLE 15,SET1AK
          TABLE 15,STPA
          TABLE 15,S1MAKX
          TABLE 15,STPK
S1MAKX    TABLE /MV,PAD+3,19/,/MV,P,09/,15,S1                          19
S1RPAR    TABLE /TM,XYE+1,02/,1,SRPAR,15,S1
S2MRZ     TABLE /CL,P,02/,8,SZ,/CL,P,01/,8,TEST3,/TM,XYS+1,0C/,1,SASTAR,X
```

```
               /CL,CODE,3B/,6,N0323,/CL,CODE+1,AA/,8,S3MB,/CL,CODE+1,3AX
               /,8,S3MB,15,N0323
N0323    TABLE /MV,PAD+3,0B/,15,S2LC
S2LC     TABLE /TM,XYE+1,08/,1,S2,/CL,N+1,04/,2,RSP,15,RSF
S2LC1    TABLE /MV,PAD+3,0B/,/TM,XYS+1,08/,8,S2MRZ,/CL,CODE,24/,8,RSS,1X
               5,RSR
S2LCY    TABLE /CL,N+1,04/,8,S2,15,RSY
S2LCZ    TABLE /CL,N+1,04/,8,S2,15,RSZ
S23MB    TABLE /CL,N+1,04/,2,S23MB1,/CL,CODE,39/,8,S0MOQ8,15,S23MB1
S23MB1   TABLE /TR,BR56+1,00/,0,BB,/SS,TEMP,00/,0,BBB
BB       DS    0H
         DC    X'00'
         DC    4X'02'
         DC    X'C0'
         DC    4X'02'
         DC    X'02'
         DC    4X'02'
         DC    X'02'
         DC    X'00'
S23MBP   EQU   *
         TABLE /TM,XYS+1,0C/,1,TEST3,/CL,PAD+3,0E/,8,S3MB,/CL,N+1,07/,2X
               ,S3MB,/TR,BR56+1,00/,0,CC,/SS,TEMP,00/,0,BBB
CC       DS    0H
         DC    X'00'
         DC    3X'02'
         DC    10X'C0'
         DC    X'02'
         DC    X'00'
         DC    X'01'
BBB      TABLE 15,S2MRZ
         TABLE 15,S0MOQ8
         TABLE 15,S3MB
S24      TABLE /TM,XYS+1,0C/,1,S4LC,/MV,PAD+3,0B/,15,S2
S4LC     TABLE /TM,XYS+1,03/,12,S4,/MV,PAD+3,38/,/EX,XS4LC,0/
S3MB     TABLE /CL,P,C1/,8,TEST3,/MV,PAD+3,0E/,15,S3LC1
S3LC     TABLE /TM,XYE+1,08/,8,RSZ,/TM,XYS+1,0C/,1,RSR,15,S3
S3LC1    TABLE /TM,XYE+1,08/,8,RSZ,/TM,XYE+1,02/,1,S3,15,RSA
S3MBR    TABLE /CL,PAD+3,04/,8,S3MBR1,/TM,CODE,03/,1,S3MBR1,/CL,N+1,04/X
               ,8,S2LC1,15,S3MBR1
S3MBR1   TABLE /CL,P,C1/,8,BR,/MV,PAD+3,04/,15,S3LC
S3SCRB   TABLE /CL,N+1,04/,2,SSCRUB,12,S3MB
S4MK     TABLE /MV,P,00/,15,S4MK1
S4MK1    TABLE /CL,P,01/,8,SK,/MV,PAD+3,33/,15,S4MK1X
S4Y      TABLE /CL,N+1,01/,12,S4Y1,2,S4MK
*2ND STROKE HAS ONLY 1 ANGLE, 1ST STROKE IS L
*DOES THE 1ST STROKE L HAVE ITS ENDPT IN RIGHT 1/4
S4Y1     TABLE /TM,XYE+1,03/,8,S4MK,15,SY
S6S      TABLE /TM,TURN+1,40/,1,SSM,15,STP6
S65      TABLE /TM,TURN,01/,1,SSM,15,STP6
S7MGK    TABLE /CL,PAD+3,18/,8,XMK1,/TR,P,00/,0,PDD,/SS,TEMP,00/,0,PDDD
PDD      DS    0H
```

```
         DC     X'02'
         DC     X'C0'
         DC     X'06'
         DC     2X'02'
         DC     X'05'
         DC     X'04'
         DC     2X'02'
         DC     X'03'
         DC     X'02'
         DC     X'01'
PDDD     TABLE 15,XMK
         TABLE 15,SK
         TABLE 15,S7X
         TABLE 15,STPK
         TABLE 15,SQ
         TABLE 15,SG
         TABLE 15,SXMSTR
S7X      TABLE /MV,PAD+3,17/,/MV,P,03/,/CL,NCUSP+1,01/,10,S7,/CL,ASPR+1X
               ,08/,2,SRPAR,15,S7
S8LCV    TABLE /MV,PAD+3,39/,/TM,XYE+1,08/,1,S2,15,S8LCVX
S9MG     TABLE /CL,P,02/,8,SG,/MV,PAD+3,34/,15,S9LC
S9LC1    TABLE /TM,XYE+1,0C/,1,SCPEL,/CL,NYMIN+1,01/,12,S9,/TM,XYS+1,0CX
               /,1,RSB,15,RSF
S9LC     TABLE /CL,NYMIN+1,01/,2,S9LC2N,4,S9LCGQ,/CL,QYMIN,03/,8,SCPAD,X
               15,S9LCGQ
S9LC2N   TABLE /CL,QYMIN+1,03/,8,SCPAD,15,S9LCGQ
S9LCGQ   TABLE /TM,XYE+1,0C/,1,S9,15,SCPGQ
S9MK     TABLE /CL,P,01/,8,SK,/MV,PAD+3,35/,15,S9
*SCRIPT LETTERS
SCPAD    TABLE /TM,XYE+1,08/,8,SCPGQ,/CL,QYMAX,00/,8,RSA,/TM,XYS+1,0C/,X
               8,RSA,15,RSD
SCPGQ    TABLE 15,RSG
SCPEL    TABLE /MV,PAD+3,38/,/EX,XSCPEL,0/
SCPMW    TABLE /EX,XSCPMW,0/
SCPPYZ   TABLE /CL,QYMIN+1,03/,8,RSP,15,SCPYZ
SCPYZ    TABLE /EX,XSCPYZ,0/
SCPBH    TABLE /TM,XYE+1,0C/,1,RSH,15,RSB
SCPMWK   TABLE /CL,QYMAX+1,00/,2,RSK,15,SCPMW
SCPNU    TABLE 15,RSN
SCPBS    TABLE /EX,XSCPBS,0/
SCPFP    TABLE /TM,XYS+1,0C/,12,SCPFPY,/MV,PAD+3,39/,/EX,XSBVMN,0/
SCPFPY   TABLE /CL,N+1,05/,12,RSF,/CL,QYMIN+1,03/,8,RSP,15,RSY
SCPNRZ   TABLE /TM,XYS+1,0C/,12,S2LCZ,/CL,N+1,04/,8,RSR,/CL,N+1,07/,2,RX
               SM,/TM,CODE,C0/,4,RSC,15,RSN
SCRPT    TABLE /TM,XYS+1,0C/,12,SCPGQ,/CL,QYMAX,00/,2,RSD,/CL,N+1,05/,1X
               2,RSR,15,RSA
SCPTX    TABLE /CL,P,01/,8,RSX,15,RST
*
*
****SET-UP CHARACTER CODE****
*
```

```
*
SA       TABLE /MV,CHAR,C1/,15,RECD
SB       TABLE /MV,CHAR,C2/,15,RECD
SCC      TABLE /MV,CHAR,C3/,15,RECD
SD       TABLE /MV,CHAR,C4/,15,RECD
SE       TABLE /MV,CHAR,C5/,15,RECD
SF       TABLE /MV,CHAR,C6/,15,RECD
SG       TABLE /MV,CHAR,C7/,15,RECD
SH       TABLE /MV,CHAR,C8/,15,RECD
SJ       TABLE /MV,CHAR,D1/,15,RECD
SK       TABLE /MV,CHAR,D2/,15,RECD
SL       TABLE /MV,CHAR,D3/,15,RECD
SM       TABLE /MV,CHAR,D4/,15,RECD
SNN      TABLE /MV,CHAR,D5/,15,RECD
SO       TABLE /MV,CHAR,D6/,15,RECD
SP       TABLE /MV,CHAR,D7/,15,RECD
SQ       TABLE /MV,CHAR,D8/,15,RECD
SR       TABLE /MV,CHAR,D9/,15,RECD
ST       TABLE /MV,CHAR,E3/,15,RECD
SU       TABLE /MV,CHAR,E4/,15,RECD
SV       TABLE /MV,CHAR,E5/,15,RECD
SW       TABLE /MV,CHAR,E6/,15,RECD
SX       TABLE /MV,CHAR,E7/,15,RECD
SY       TABLE /MV,CHAR,E8/,15,RECD
SZ       TABLE /MV,CHAR,E9/,15,RECD
S0       TABLE /MV,CHAR,F0/,15,RECD
S1       TABLE /MV,CHAR,F1/,15,POSTST
S2       TABLE /MV,CHAR,F2/,15,RECD
S3       TABLE /MV,CHAR,F3/,15,RECD
S4       TABLE /MV,CHAR,F4/,15,RECD
S5       TABLE /MV,CHAR,F5/,15,RECD
S6       TABLE /MV,CHAR,F6/,15,RECD
S7       TABLE /MV,CHAR,F7/,15,RECD
S8       TABLE /MV,CHAR,F8/,15,RECD
S9       TABLE /MV,CHAR,F9/,15,RECD
SEQL     TABLE /MV,CHAR,FE/,15,RECD
SKARAT   TABLE /MV,CHAR,70/,15,RECD
SLBRAC   TABLE /MV,CHAR,CF/,15,RECD
SLKRT    TABLE /MV,CHAR,EE/,15,RECD
SLPAR    TABLE /MV,CHAR,CD/,15,POSTST
SMINUS   TABLE /MV,CHAR,E0/,15,RECD
SPER     TABLE /MV,CHAR,CB/,15,RECD
SPLUS    TABLE /MV,CHAR,CE/,15,RECD
SPOUND   TABLE /MV,CHAR,FB/,15,RECD
SRBRAC   TABLE /MV,CHAR,DF/,15,RECD
SRKRT    TABLE /MV,CHAR,CC/,15,RECD
SRPAR    TABLE /MV,CHAR,DD/,15,POSTST
SSCRUB   TABLE /MV,CHAR,72/,15,RECD
SSLASH   TABLE /MV,CHAR,E1/,15,POSTST
SSTAR    TABLE /MV,CHAR,DC/,15,RECD
STILDA   TABLE /MV,CHAR,D0/,15,RECD
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```
DK        TABLE /MV,CHAR,EF/,15,RECD
SBOX      TABLE /MV,CHAR,73/,15,RECD
SCIRC     TABLE /MV,CHAR,74/,15,RECD
SELIPS    TABLE /MV,CHAR,76/,15,RECD
SPBOX     TABLE /MV,CHAR,77/,15,RECD
STRAP     TABLE /MV,CHAR,78/,15,RECD
STRI      TABLE /MV,CHAR,75/,15,RECD
RSA       TABLE /MV,CHAR,81/,15,RECD
RSB       TABLE /MV,CHAR,82/,15,RECD
RSC       TABLE /MV,CHAR,83/,15,RECD
RSD       TABLE /MV,CHAR,84/,15,RECD
RSE       TABLE /MV,CHAR,85/,15,RECD
RSF       TABLE /MV,CHAR,86/,15,RAZER
RSG       TABLE /MV,CHAR,87/,15,RAZER
RSH       TABLE /MV,CHAR,88/,15,RECD
RSI       TABLE /MV,CHAR,89/,15,RECD
RSJ       TABLE /MV,CHAR,91/,15,RAZER
RSK       TABLE /MV,CHAR,92/,15,RECD
RSL       TABLE /MV,CHAR,93/,15,RECD
RSM       TABLE /MV,CHAR,94/,15,RECD
RSN       TABLE /MV,CHAR,95/,15,RECD
RSO       TABLE /MV,CHAR,96/,15,RECD
RSP       TABLE /MV,CHAR,97/,15,RAZER
RSQ       TABLE /MV,CHAR,98/,15,RAZER
RSR       TABLE /MV,CHAR,99/,15,RECD
RSS       TABLE /MV,CHAR,A2/,15,RECD
RST       TABLE /MV,CHAR,A3/,15,RECD
RSU       TABLE /MV,CHAR,A4/,15,RECD
RSV       TABLE /MV,CHAR,A5/,15,RECD
RSW       TABLE /MV,CHAR,A6/,15,RECD
RSX       TABLE /MV,CHAR,A7/,15,RECD
RSY       TABLE /MV,CHAR,A8/,15,RAZER
RSZ       TABLE /MV,CHAR,A9/,15,RAZER
*
*
****PAD TABLE****
*
*
PADT      EQU   *
          TABLE 15,DK
          TABLE 15,SDP
          TABLE 15,STP6                     02
          TABLE 15,STP5
          TABLE 15,S3MBR1                   04
          TABLE 15,SCMG                     05
          TABLE 15,KVXYM                    06
          TABLE 15,SETXX                    07
          TABLE 15,SEGC6M                   08
          TABLE 15,SOMDQ8                   09
          TABLE 15,G6ETST                   0A
          TABLE 15,S2MRZ                    0B
```

```
         TABLE 15,SPRMA                OC
         TABLE 15,SBARMK               OD
         TABLE 15,S3MB                 OE
         TABLE 15,SUMAM                OF
         TABLE 15,SRPRM                10
         TABLE 15,SRPRM
         TABLE 15,SSM                  12
         TABLE 15,SSM
         TABLE 15,SCOMAM               14
         TABLE 15,SAMST1               15
         TABLE 15,SCMEG                16
         TABLE 15,S7MGK                17
         TABLE 15,XMK1                 18
         TABLE 15,S1MAK                19
         TABLE 15,SLMEK4               1A
         TABLE 15,STPE                 1B
         TABLE 15,SVM                  1C
         TABLE 15,SVM
         TABLE 15,TEST5                1E
         TABLE 15,SFE                  1F
         TABLE 15,SFME1                20
         TABLE 15,OQ                   21
         TABLE 15,SDMH                 22
         TABLE 15,FIME1                23
         TABLE 15,KNYM1
         TABLE 15,AHSTR                25
         TABLE 15,SBM51                26
         TABLE 15,SUMXX                27
         TABLE 15,SK5                  28
         TABLE 15,SNMA                 29
         TABLE 15,SRPRMJ               2A
         TABLE 15,STPA                 2B
         TABLE 15,SE                   2C
         TABLE 15,STPH8                2D
         TABLE 15,STPK1                2E
         TABLE 15,SJ                   2F
         TABLE 15,STPM                 30
         TABLE 15,SUMJU                31
         TABLE 15,SXMST1               32
         TABLE 15,S4MK1                33
         TABLE 15,S9MG                 34
         TABLE 15,S9MK                 35
         TABLE 15,TPLUSM               36
         TABLE 15,SA7
         TABLE 15,SCPTX                38
         TABLE 15,RSX                  39
         TABLE 15,SPOUND               3A
*
*
****4 DIRECTION TABLE****
*
```

```
*
AAAA     TABLE /SS,TEMP,OO/,O,AAA
AAA      EQU   *
         TABLE 15,RECD
         TABLE 15,STPM
         TABLE 15,S23MB
         TABLE 15,S23MBP
         TABLE 15,SMC
         TABLE 15,SS8M
         TABLE 15,SG069M
         TABLE 15,SS589M
         TABLE 15,SG06M
         TABLE 15,SBDPR
         TABLE 15,SMNW
         TABLE 15,SM1M
         TABLE 15,SBARM
         TABLE 15,S2MRZ
         TABLE 15,S3MB
         TABLE 15,S3MBR
         TABLE 15,STP6
         TABLE 15,S24
         TABLE 15,SRPRM
         TABLE 15,DK
         TABLE 15,S7MGK
         TABLE 15,STPA
         TABLE 15,S1MAK
         TABLE 15,SNMA
         TABLE 15,SMLC
         TABLE 15,SCOMAM
         TABLE 15,SBARMK
         TABLE 15,SSM
         TABLE 15,S9MK
         TABLE 15,SCMEG
         TABLE 15,SFE
         TABLE 15,SLMEK4
         TABLE 15,SUMJU
         TABLE 15,S5
         TABLE 15,STP5
         TABLE 15,SK5
         TABLE 15,STPH8
         TABLE 15,SVM
         TABLE 15,SDMH
         TABLE 15,SUMAM
         TABLE 15,STPJ
         TABLE 15,SGSCRB
         TABLE 15,S3SCRB
         TABLE 15,BR
         TABLE 15,SBDPR1
         TABLE 15,SLKRTM
         TABLE 15,SRPRMJ    2E
         TABLE 15,SGS
         TABLE 15,SGS06M
         TABLE 15,S0M0Q8
         TABLE 15,S8        32
         TABLE 15,SG        33
         TABLE 15,S9        34
         TABLE 15,S3        35
         TABLE 15,SASTAR    36
         TABLE 15,SCC       37
         TABLE 15,SA7       38
         TABLE 15,SCG       39
         TABLE 15,SG81                 3A
         TABLE 15,S023MB               3B
         TABLE 15,S09                  3C
         TABLE 15,S9LC1
         TABLE 15,S09M
         TABLE 15,SCRPT
         TABLE 15,RSC
         TABLE 15,SCPFP
         TABLE 15,SCPEL
         TABLE 15,RSS
         TABLE 15,RSV
         TABLE 15,SCPNRZ
         TABLE 15,RSZ
         TABLE 15,SE
         TABLE 15,SCPGQ
         TABLE 15,S8LCV                49
         TABLE 15,SEQ                  4A
*
*
****SET OF ESCAPES****
*
*
AHSTRX   TABLE /EX,XAHSTR,0/
KNY      TABLE /EX,XKNY,0/
FI       TABLE /EX,XFI,0/
KVXY     TABLE /EX,XKVXY,0/
MW       TABLE /EX,XMW,0/
MWIN     TABLE /EX,XMWIN,0/
MW1      TABLE /EX,XMW1,0/
POSTST   TABLE /EX,XPOST,0/
RAZER    TABLE /EX,XRAZE,0/
RECD     TABLE /EX,XRECD,0/
SDP      TABLE /EX,XSDP,0/
SMNW     TABLE /EX,XSMNW,0/
SM1M     TABLE /EX,XSM1M,0/
SRPRM    TABLE /EX,XSRPRM,0/
SSM      TABLE /EX,XSSM,0/
SVM      TABLE /EX,XSVM,0/
TEST1    TABLE /EX,XTEST1,0/
TEST3    TABLE /EX,XTEST3,0/
TPLUS    TABLE /EX,XTPLUS,0/
```

```
S8LCVX   TABLE /EX,XS8LCV,0/
SRLCX    TABLE /EX,XSRLC,0/
S4MK1X   TABLE /EX,XS4MK1,0/
*
*
****ENTRY SWITCH****
*
*
GPSW     TABLE /SS,CUSP,CO/,0,GPSWTCH
GPSWTCH  EQU   *
         TABLE 15,SPER
         TABLE 15,SXHBL
         TABLE 15,S4
         TABLE 15,SK
         TABLE 15,AAAA
         TABLE 15,KVXYM
         TABLE 15,PADEX
         TABLE 15,TPLUSM
         TABLE 15,SBM5
         TABLE 15,SJMU
         TABLE 15,SUMJU1
         TABLE 15,SM1
         TABLE 15,SXMSTR
         TABLE 15,SCMCQ8
         TABLE 15,SCPNU
         TABLE 15,RSB
         TABLE 15,RSC
         TABLE 15,RSE
         TABLE 15,RSF
         TABLE 15,RSG
         TABLE 15,RSI
         TABLE 15,RSJ
         TABLE 15,RSL
         TABLE 15,RSM
         TABLE 15,RSN
         TABLE 15,RSO
         TABLE 15,RSR
         TABLE 15,RSS
         TABLE 15,RSU
         TABLE 15,RSV
         TABLE 15,RSW
         TABLE 15,RSY
         TABLE 15,RSZ
         TABLE 15,SA
         TABLE 15,SG
         TABLE 15,SM
         TABLE 15,SNN
         TABLE 15,SP
         TABLE 15,SR
         TABLE 15,SU
         TABLE 15,SO
         TABLE 15,S8
         TABLE 15,SSTAR
         TABLE 15,SSCRUB
         TABLE 15,DK
         TABLE 15,RSA
         TABLE 15,SE
*
ENDMARK  EQU   *
         END
```

REC RCS'S

AHSTR1

```
*FUNCTION
*
*DISTINGUISHES AMONG 3-STROKE A, H, K, AND * BASED ON POSITIONS OF
*STARTING AND ENDING POINTS
*
*
*
*CALL
*        RCS   AHSTR1A,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R9-R14
*
*
         USING XR6,R6
EX0      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
XYEP     EQU   X'40'
XYSP     EQU   X'4A'
XSPI     EQU   X'72'
YSPI     EQU   X'7C'
```

```
XEPI      EQU   X'86'
YEPI      EQU   X'90'
          DS    3F
          DS    26H
          DS    20C
          DS    3F
          DS    1H
          DS    2C
          DS    3H
P         DS    1C
CHAR      DS    1C
AHSTR1    BOX
*R10 IS FIRST VERTICAL STROKE REF
*R11 IS SECOND VERTICAL STROKE REF
*R12 IS HORIZONTAL STROKE REF
*IS THIRD STROKE HORIZONTAL?
          CLI   P,X'C2'
          BC    8,H3
*NO, IS FIRST HORIZONTAL?
          LA    R11,4(R6)
          LH    R7,XEPI(R6)
          SH    R7,XSPI(R6)
          LPR   R7,R7
          LH    R9,YEPI(R6)
          SH    R9,YSPI(R6)
          LPR   R9,R9
          CR    R7,R9
          BC    2,H1
*NO, SECOND STROKE IS THE HORIZONTAL
          LA    R12,2(R6)
          LA    R10,0(R6)
          B     HDONE
*THIRD STROKE IS THE HORIZ
H3        LA    R12,4(R6)
          LA    R11,2(R6)
          LA    R10,0(R6)
          B     HDONE
*FIRST STROKE IS THE HORIZ
H1        LA    R12,0(R6)
          LA    R10,2(R6)
HDONE     EQU   *
*TEST FOR K
*ARE BOTH VERT ENDPTS AT THE LEFT
          TM    XYEP+1(R10),X'03'
          BC    12,NOTK
          TM    XYEP+1(R11),X'03'
          BC    1,SKX
          TM    XYSP+1(R10),X'03'
          BC    12,NOTK
*IS HORIZ START OR END POINT IN UPPER RIGHT?
          CLI   XYEP+1(R12),X'00'
```

```
         BC    8,ETOP
         CLI   XYEP+1(R12),X'01'
         BC    8,ETOP
         CLI   XYSP+1(R12),X'00'
         BC    8,STOP
         CLI   XYSP+1(R12),X'01'
         BC    6,NOTK
*IS TOP,RIGHT PART OF HORIZ ABOVE TOP OF SECOND VERT?
STOP     EQU   *
         LH    R13,YSPI(R12)
         B     ETOP1
ETOP     EQU   *
         LH    R13,YEPI(R12)
ETOP1    EQU   *
         CH    R13,YSPI(R11)
         BC    2,SKX
NOTK     EQU   *
*NOT K, TEST FOR A,H, OR *
*ARE START PTS CLOSE COMPARED TO ENDPTS
         LH    R13,XEPI(R10)
         SH    R13,XEPI(R11)
         LPR   R13,R13
         SRL   R13,2                    1/4 MAG OF ENDPT DIFF
         LH    R14,XSPI(R10)
         SH    R14,XSPI(R11)
         LPR   R14,R14
         CR    R14,R13
         BC    4,SAX
*NO, DO VERTICAL STROKES CROSS?
         LH    R13,XEPI(R10)
         CH    R13,XEPI(R11)
         BC    2,END1R
         LH    R13,XSPI(R10)
         CH    R13,XSPI(R11)
         BC    2,SSTARX
         B     SHX
END1R    EQU   *
         LH    R13,XSPI(R10)
         CH    R13,XSPI(R11)
         BC    4,SSTARX
         B     SHX
SAX      EQU   *
         MVI   CHAR,C'A'
         BC    15,BEXIT1
SHX      EQU   *
         MVI   CHAR,C'H'
         BC    15,BEXIT1
SKX      EQU   *
         MVI   CHAR,C'K'
         BC    15,BEXIT1
SSTARX   EQU   *
```

```
         MVI   CHAR,X'DC'
BEXIT1   MVI   P,X'CC'
         BEXIT EXO
         END
```

BFI

```
*FUNCTION
*
*DISTINGUISHES AMONG 3-STROKE F, I, AND * BASED ON POSITIONS OF START-
*ING POINTS
*
*
*
*CALL
*        RCS   BFIA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R12, R13, R15
*
*
         USING XR6,R6
         REGS
EXO      EQU   0
D6       DSECT
XR6      DS    0F
XYSP     EQU   X'4A'                    XYS (R6)
         DS    3F
         DS    26H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
BFI      BOX
FI       SR    R15,R15
         LA    R12,2
         LA    R13,4
FI1      LA    R7,0(R6,R15)
         TM    XYSP+1(R7),X'03'
         MVI   CHAR,X'DC'              ASTERISK
         BC    8,FIX
         MVI   CHAR,C'I'
         TM    XYSP+1(R7),X'0C'
         BC    1,FIX
         BXLE  R15,R12,FI1
         MVI   CHAR,C'F'
FIX      BEXIT EX0
         END
```

BHITE

```
*FUNCTION
*
*DISTINGUISHES BETWEEN TALL AND SHORT CHARACTERS.  A SHORT CHARACTER
*IS ONE SHORTER THAN 3/4 OF THE NORMALLY EXPECTED CHARACTER HEIGHT
*('CHAREC' SETS DYM = 3/2 NORMAL CHARACTER HEIGHT).
*
*
*
*CALL
*        RCS   BHITEA,ESHORT,ETALL
*EXIT SHORT WHEN THE CHARACTER IS SHORT
*EXIT TALL WHEN THE CHARACTER IS TALL
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R8
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
EX4      EQU   4
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    20H
YTC      DS    1H
YBC      DS    1H
         DS    4H
         DS    20C
         DS    3F
         DS    1H
```

```
          DS     2C
          DS     3H
          DS     56C
          DS     14H
DYM       DS     1H
BHITE     BOX
          LH     R7,YTC
          SH     R7,YBC
          LH     R8,DYM                         3/2 NORM CHAR HITE
          SRL    R8,1                           3/4 NORM CHAR HITE
          CR     R7,R8
          BC     4,LOX
HIX       BEXIT  EX4
LOX       BEXIT  EX0
          END
```

BSDP

```
*FUNCTION
*
*DISTINGUISHES AMONG'D, P, 5, AND SCRIPT B BASED ON THE POSITION
*OF THE LAST STROKE ENDPOINT, THE POSITION OF THE 2ND REL. Y MAX. IN
*THIS STROKE, AND THE NO. OF STROKES
*
*
*
*CALL
*         RCS    BSDPA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R15
*
*
          USING XR6,R6
          REGS
EX0       EQU    0
D6        DSECT
XR6       DS     0F
XYEP      EQU    X'40'                          XYE (R6)
          DS     1F
PAD       DS     1F
          DS     1F
```

```
         DS     11H
SN       DS     1H
         DS     14H
         DS     20C
         DS     3F
         DS     1H
         DS     2C
         DS     3H
P        DS     1C
CHAR     DS     1C
         DS     54C
         DS     21H
         DS     1F
         DS     6C
         DS     1H
         DS     1F
         DS     20C
         DS     33H
QYMAX    DS     10C
BSDP     BOX
         CLI    PAD+3,X'01'
         BC     8,SDM51
         MVI    PAD+3,X'01'
SDP      LH     R15,SN
         BCT    R15,SDP1
SDP1     SLL    R15,1
         LA     R7,0(R6,R15)
         TM     XYEP+1(R7),X'0C'
         MVI    CHAR,C'P'
         BC     12,SDPX
SDM5     MVI    P,X'00'
         MVI    CHAR,C'D'
         CLI    SN+1,X'02'
         BC     8,SDSD
         CLI    QYMAX+1,X'00'
         BC     8,SDSD
         MVI    CHAR,X'82'                  LC B
         B      SDPX
SDM51    CLI    P,X'02'
         MVI    CHAR,C'5'
         BC     8,SDPX
         MVI    CHAR,C'D'
SDSD     EQU    *
SDPX     BEXIT  EXO
         END
```

BSMNW

```
*FUNCTION
*
*DISTINGUISHES AMONG SCRUB, N, W, SCRIPT Y, AND A CHARACTER GROUP (M,
*SCRIPT M, SCRIPT W, SCRIPT Y) BASED ON NO. OF DIRECTIONS, ASPECT RATIO
*AND THE POSITION OF THE FIRST REL. Y MIN.
*
*
*
*CALL
*        RCS   BSMNWA,ECHAR,EGROUP,ERAZE
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*EXIT GROUP WHEN THE CHARACTER IS M, OR SCRIPT M, W, OR Y
*EXIT RAZE WHEN THE CHAR. IS RECOGNIZED AS A SCRIPT Y, AND THE CHAR
* CENTER MUST BE RAISED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7,R8
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
EX4      EQU   4
EX8      EQU   8
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    10H
N        DS    1H
         DS    5H
DXC      DS    1H
         DS    5H
ASPR     DS    1H
         DS    3H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
         DS    6C
XSP      DS    10C
         DS    38C
         DS    21H
         DS    1F
         DS     6C
         DS     1H
         DS     1F
         DS     20C
         DS     33H
QYMAX    DS     10C
QYMIN    EQU    QYMAX+5
         DS     2H
YMAXX    DS     10H
BSMNW    BOX
SMNW     CLI    N+1,X'C5'
         BC     4,TEST4
         BC     8,SMLCX
         MVI    CHAR,X'72'              SCRUB
         B      SMNWX
TEST4    CLI    ASPR+1,X'04'
         MVI    CHAR,C'W'
         BC     4,SMNWX
*N IF A  SP RATIO GTR THAN 2
         CLI    ASPR+1,X'08'
         BC     2,SNLCY
*ARE THE SP AND 2ND MAX CLOSER THAN
*3/8 CHARACTER WIDTH
         LH     R7,DXC
         SRL    R7,2  1/4 DELTA X
         LR     R8,R7
         SRL    R8,1
         AR     R7,R8                   3/8 DELTA X
         LH     R8,YMAXX+2
         SH     R8,XSP
         LPR    R8,R8
         CR     R8,R7
         BC     4,SNLCY
         MVI    CHAR,C'W'               NO
         B      SMNWX
SNLCY    MVI    CHAR,C'N'
         CLI    QYMIN,X'03'
         BC     8,SMNWX
         MVI    CHAR,X'A8'              LC Y
         BEXIT EX8
SMNWX    BEXIT EX0
SMLCX    BEXIT EX4
         END
```

BSRPRM

```
*FUNCTION
*
*DISTINGUISHES AMONG R, 3, 5, RIGHT BRACKET, AND 2 GROUPS OF CHARACTERS
*(D, P), (RIGHT PAREN., COMMA, APOSTROPHE) BASED ON THE IDENTITY OF THE
*THE PREVIOUS SUBCHARACTER, THE NO. OF GEOM. CORNERS, AND THE POSITION
*OF A CORNER
*
*
*
*CALL
*        RCS   BSRPRMA,ECHAR,EDP,EPAREN
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*EXIT DP WHEN THE CHARACTER IS A D OR P
*EXIT PAREN WHEN THE CHARACTER IS A RIGHT PAREN., COMMA, OR APOSTROPHE,
* TEST SIZE AND POSITION
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R8
*
*
         USING XR6,R6
EX0      EQU   0
EX4      EQU   4
EX8      EQU   8
         REGS
D6       DSECT
XR6      DS    0F
         DS    1F
PAD      DS    1F
         DS    1F
         DS    20H
YTC      DS    1H
YBC      DS    1H
         DS    4H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
NCUSP    DS    1H
         DS    2H
P        DS    1C
CHAR     DS    1C
         DS    54C
         DS    21H
         DS    1F
         DS    6C
         DS    1H
         DS    1F
         DS    10C
YC       DS    10C
BSRPRM   BOX
         CLI   PAD+3,X'11'
         BC    8,DPMR1
SRPRM    CLI   P,X'01'
         BC    8,DPMR
         CLI   P,X'02'
         MVI   CHAR,C'5'
         BC    8,SRPRMX
         CLI   P,X'0B'
         MVI   CHAR,C'R'
         BC    8,SRPRMX
         MVI   PAD+3,X'10'             SRPRM
         CLI   NCUSP+1,X'03'
         MVI   CHAR,C'3'
         BC    10,SRPRMX
         CLI   NCUSP+1,X'01'
RBRAKX   MVI   CHAR,X'DF'              RIGHT BRACKET
         BC    2,SRPRMX
         MVI   CHAR,X'DD'              RIGHT PARENTHESIS
         BC    4,SRPMX1
*3 IF T  HE CUSP IS IN THE MIDDLE
         LH    R7,YTC
         SH    R7,YBC
         SRL   R7,1  1/2 DELTA Y
         LR    R8,R7
         SRL   R8,1  1/4 DELTA Y
         AH    R8,YBC
         AR    R7,R8
         CH    R8,YC
         BC    2,RBRAKX
         CH    R7,YC
         MVI   CHAR,C'3'               MIDDLE
         BC    10,SRPRMX
         BC    4,RBRAKX
DPMR     MVI   P,X'00'
DPMR1    CLI   P,X'01'
         MVI   CHAR,C'R'
         BC    8,SRPRMX
         MVI   PAD+3,X'11'             DPMR1
         BEXIT EX4
SRPRMX   BEXIT EX0
SRPMX1   BEXIT EX8
         END
```

BSSM

```
*FUNCTION
*
*DISTINGUISHES AMONG S, 5, 8, 9, AND $ BASED ON THE GENERAL IDENTITY OF
*THE PREVIOUS SUBCHARACTER, THE POSITION OF THE ENDPOINT, THE NO. OF
*DIRECTIONS, THE FIRST DIRECTION, AND THE NO. OF TIME-CORNERS
*
*
*
*CALL
*          RCS    BSSMA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTER.  R7
*
*
          USING XR6,R6
          REGS
EXO       EQU    0
D6        DSECT
XR6       DS     0F
          DS     1F
PAD       DS     1F
CODE      DS     1F
          DS     10H
N         DS     1H
          DS     7H
XRC       DS     1H
XLC       DS     1H
          DS     6H
XYE       DS     10C
          DS     10C
          DS     3F
          DS     1H
          DS     2C
NCUSP     DS     1H
          DS     2H
P         DS     1C
CHAR      DS     1C
TEMP      DS     1C
          DS     53C
          DS     21H
          DS     1F
          DS     6C
          DS     1H
          DS     1F
```

```
XC       DS    10C
         DS    10C
         DS    17H
NTCUSP   DS    1H
BSSM     BOX
         CLI   PAD+3,X'13'
         BC    8,DOLDOL
SSM      MVC   TEMP(1),P
         TR    TEMP(1),LL
         SR    R7,R7
         IC    R7,TEMP
         EX    0,LLL(R7)
SSM1     MVI   P,X'05'
         MVI   PAD+3,X'12'                 SSM
         TM    XYE+1,X'08'
         BC    8,S8S8
*NOT 5   IF 1ST ANGLE IS 1
         TM    CODE,X'80'
         BC    1,SSM2
         TM    CODE,X'40'
         BC    1,S9
*TEST FOR TIME CORNERS
SSM2     EQU   *
         CLI   NTCUSP+1,X'01'
         BC    2,S5S5                      2
         BC    4,SSSS                      NONE
*1 TIME CORNER, CHECK FOR GEOM CORNERS
         CLI   NCUSP+1,X'02'
         BC    2,S5S5
         BC    4,SSSS
         LH    R7,XRC
         SH    R7,XLC
         SRL   R7,1  1/2 DELTA X
         AH    R7,XLC
         CH    R7,XC+2
         BC    2,S5S5                      LEFT
         BC    12,SSSS                     RIGHT
LL       DS    0H
         DC    X'00'
         DC    X'04'
         DC    X'10'
         DC    2X'00'
         DC    3X'08'
         DC    3X'0C'
         DC    X'0C'
LLL      DS    0H
         BC    15,SSM1
         BC    15,STPDOL
         BC    15,S8S8
         BC    15,DOLDOL
         BC    15,S5S5
```

```
*POSSIBLE 9, TEST ANGLES, AND TIMWE CORNERS
S9       CLI   N+1,X'06'
         BC    4,SSSS
         CLI   NTCUSP+1,X'01'
         BC    4,SSSS
S9S9     MVI   CHAR,C'9'
         B     SSMX
STPDOL   MVI   P,X'00'
         MVI   PAD+3,X'13'              DOLDOL
DOLDOL   MVI   CHAR,X'DB'               DOLLARS
         BC    15,SSMX
S5S5     MVI   CHAR,C'5'
         BC    15,SSMX
SSSS     MVI   CHAR,C'S'
         BC    15,SSMX
S8S8     MVI   CHAR,C'8'
         BC    15,SSMX
SSMX     BEXIT EXO
         END
```

BSVM

```
*FUNCTION
*
*DISTINGUISHES AMONG V, W, AND 5 GROUPS OF CHARACTERS (J, U), (M, W),
*(K, N, Y), (O, 8, D, Q), (U, 8) BASED ON THE GENERAL IDENTITY OF THE
*PREVIOUS SUBCHARACTER, THE ORIGIN OF THE CALL TO THIS ROUTINE (TEMP
*HAS BEEN ENCODED AS C IN 'INTERP' IF THE CHAR CAN BE U), AND THE DIS-
*TANCE BETWEEN THE STARTING AND ENDING POINTS
*
*
*
*CALL
*        RCS   BSVMA,ECHAR,EJU,EMW,EKNY,EO8DQ,EU8
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*EXIT JU WHEN THE CHAR IS J, POTENTIALLY U
*EXIT MW WHEN THE CHAR IS M OR W
*EXIT KNY WHEN THE CHAR IS K, N, OR Y
*EXIT O8DQ WHEN THE CHAR IS O, POTENTIALLY 8, D, OR Q
*EXIT U8 WHEN THE CHAR IS U, POTENTIALLY 8
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7,R8,R10
```

```
*
*
          USING XR6,R6
EX0       EQU   0
          REGS
EX4       EQU   4
EX8       EQU   8
EX12      EQU   12
EX16      EQU   16
EX20      EQU   20
D6        DSECT
XR6       DS    0F
          DS    1F
PAD       DS    1F
          DS    1F
          DS    18H
XRC       DS    1H
XLC       DS    1H
          DS    6H
          DS    20C
          DS    3F
          DS    1H
          DS    2C
          DS    3H
P         DS    1C
CHAR      DS    1C
TEMP      DS    1C
          DS    5C
XSP       DS    10C
          DS    10C
XEP       DS    10C
BSVM      BOX
          CLI   PAD+3,X'1D'
          BC    8,KNYXXX
          CLI   PAD+3,X'1E'
          BC    8,TEST5
SVM       CLI   P,X'01'
          BC    8,KNYMMW
          CLI   P,X'02'
          BC    8,SJMUXX
          CLI   P,X'0B'
          BC    8,MW1X
          CLI   P,X'04'
          MVI   CHAR,C'W'
          MVI   TEMP,X'C4'
          BC    15,TEST5
          BC    8,SVMX
SVM1      MVI   PAD+3,X'1C'                SVM
          MVI   P,X'C4'
          MVI   CHAR,C'V'
          BC    15,SVMX
```

```
KNYMMW   MVI   P,X'CC'
KNYXXX   CLI   P,X'01'
         BC    8,MW1X
         MVI   PAD+3,X'1D'              KNYXXX
         BC    15,KNY1X
**0 VS   U,V TEST
*0 IF S  TARTPT AND ENDPT ARE CLOSER THAN
*1/2 CH  ARACTER WIDTH
*TEMP CO NTAINS CODE FOR RETURN TO U OR V
TEST5    LH    R7,XSP
         SH    R7,XEP
         LPR   R7,R7
         LH    R8,XRC
         SH    R8,XLC
         LPR   R8,R8
         SRL   R8,1
         CR    R7,R8
         BC    4,SOMX
*ENDPT   IN LEFT OR RIGHT 1/4
         SR    R10,R10
         IC    R10,TEMP
         EX    0,T5SW(R10)
T5SW     DS    0F
         BC    15,SUJU1X
         BC    15,SVM1
SVMX     BEXIT EX0
SJMUXX   BEXIT EX4
MW1X     BEXIT EX8
KNY1X    BEXIT EX12
SOMX     BEXIT EX16
SUJU1X   BEXIT EX20
         END
```

BTEST1

```
*FUNCTION
*
*DISTINGUISHES BETWEEN TWO CHARACTER GROUPS (8, SCRIPT G), (S-LIKE
*CHARACTERS) BASED ON THE POSITION OF THE ENDPOINT
*
*
*CALL
*        RCS   BTEST1A,E8G,ESSM
*EXIT 8G WHEN CHAR IS 8 OR SCRIPT G, TEST DIRECTIONS
*EXIT SSM WHEN CHAR IS S-LIKE, TEST FURTHER WITH BSSM
*
```

```
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R15
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
EX4      EQU   4
D6       DSECT
XR6      DS    0F
XYEP     EQU   X'40'                  XYE
         DS    3F
         DS    11H
SN       DS    1H
         DS    14H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
BTEST1   BCX
TEST1    LH    R15,SN
         BCT   R15,TEST11
TEST11   SLL   R15,1
         LA    R7,0(R6,R15)
         TM    XYEP+1(R7),X'C8'
         BC    1,SSMXXX
         MVI   CHAR,C'8'
         BEXIT EX0
SSMXXX   BEXIT EX4
         END
```

BTEST3

```
*FUNCTION
*
*DISTINGUISHES AMONG B, R, U, SCRIPT K, SCRIPT X, AND A CHARACTER GROUP
*(5, B) BASED ON THE NO. OF STROKES, THE POSITIONS OF STARTING AND END-
*ING POINTS, THE DIRECTIONS, THE POSITIONS OF REL. Y MAXIMA
*
*
*
*CALL
```

```
*        RCS   BTEST3A,ECHAR,E5B
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*EXIT 5B WHEN CHAR IS 5, POTENTIALLY B
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R8
*
*
         USING XR6,R6
         REGS
EX0      EQU   0
EX4      EQU   4
D6       DSECT
XR6      DS    0F
XYSP     EQU   X'4A'                   XYS
XYEP     EQU   X'40'                   XYE
         DS    2F
CODE     DS    1F
         DS    11H
SN       DS    1H
         DS    4H
DXC      DS    1H
         DS    1H
XRC      DS    1H
         DS    7H
XYE      DS    10C
         DS    10C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
         DS    54C
         DS    21H
         DS    1F
         DS    6C
         DS    1H
         DS    1F
         DS    20C
         DS    33H
QYMAX    DS    10C
         DS    2H
YMAXX    DS    10H
BTEST3   BOX
TEST3    CLI   SN+1,X'01'
         BC    8,TEST31
*2 STROKE CHARACTERS
```

```
         LH    R8,SN
         BCT   R8,TEST32
TEST32   SLL   R8,1
         LA    R8,0(R8,R6)
         MVI   CHAR,X'A7'                LC X
         TM    XYSP+1(R8),X'02'
         BC    8,TEST3X
         TM    XYEP+1(R8),X'02'
         MVI   CHAR,C'B'
         BC    1,TEST3X                  END IN LEFT HALF
         MVI   CHAR,C'R'
         BC    8,TEST3X                  END IN RIGHT HALF
*SINGLE STROKE CHARACTERS
TEST31   TM    XYE+1,X'02'
         BC    1,SBM5X
         MVI   CHAR,C'R'                 END IN RIGHT HALF
RLC      EQU   *
         CLI   CODE,X'DC'                3130
         BC    8,RU
         CLI   QYMAX+1,X'00'
         BC    8,TEST3X
         MVI   CHAR,X'92'                K
         B     TEST3X
RU       EQU   *
         LH    R8,DXC
         SRL   R8,1
         LH    R7,XRC
         SR    R7,R8
* IS MAX 2 IN RIGHT 1/2
         CH    R7,YMAXX+2
         BC    2,TEST3X                  NO,R
         MVI   CHAR,C'U'
TEST3X   BEXIT EXC
SBM5X    BEXIT EX4
         END
```

<u>KNYTST</u>

```
*FUNCTION
*
*DISTINGUISHES AMONG 3-STROKE (ALL VERT) K, N, AND Y BASED ON THE POS-
*ITIONS OF THE STARTING AND ENDING POINTS
*
*
*
*CALL
```

```
*         RCS   KNYTSTA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7-R13, R15
*
*
          USING XR6,R6
EXO       EQU   0
          REGS
D6        DSECT
XR6       DS    0F
XYSP      EQU   X'4A'
XYEP      EQU   X'40'
          DS    3F
          DS    26H
XYE       DS    10C
XYS       DS    10C
          DS    3F
          DS    1H
          DS    2C
          DS    3H
          DS    1C
CHAR      DS    1C
KNYTST    BOX
          SR    R9,R9
          SR    R10,R10
          SR    R11,R11
          LA    R12,2
          LA    R13,4
          SR    R15,R15
KNYIN     LA    R8,0(R6,R15)
          TR    XYSP+1(1,R8),HHS
          LH    R7,XYS(R15)
          EX    0,HHHS(R7)
KNYSN     CR    R9,R12
          BC    8,SNX
          LR    R9,R12
KNYSKY    TR    XYEP+1(1,R8),HHE
          LH    R7,XYE(R15)
          EX    0,HHHE(R7)
KNYEY     CR    R10,R12
          BC    8,SYX
          LR    R10,R12
          BC    15,KNYI
KNYEN     CR    R11,R12
          BC    8,SNX
          LR    R11,R12
```

```
KNYI      BXLE  R15,R12,KNYIN
SKXX      EQU   *
          MVI   CHAR,C'K'
          BC    15,BEXIT2
SNX       EQU   *
          MVI   CHAR,C'N'
          BC    15,BEXIT2
SYX       EQU   *
          MVI   CHAR,C'Y'
BEXIT2    BEXIT EXO
HHHS      DS    0F
          BC    15,KNYSKY
          BC    15,KNYSN
HHHE      DS    0F
          BC    15,KNYI
          BC    15,KNYEY
          BC    15,KNYEN
HHS       DS    0H
          DC    2X'00'
          DC    2X'04'
          DC    3X'00'
          DC    X'04'
          DC    8X'00'
HHE       DS    0H
          DC    5X'00'
          DC    2X'04'
          DC    X'00'
          DC    X'08'
          DC    2X'04'
          DC    X'00'
          DC    2X'08'
          DC    2X'00'
          END
```

<u>KNY1T</u>

```
*FUNCTION
*
*DISTINGUISHES AMONG 2-STROKE (1 VERT, 1 V-LIKE) K, N, AND Y BASED ON
*THE POSITIONS OF THE STARTING AND ENDING POINTS
*
*
*
*CALL
*         RCS   KNY1TA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
```

```
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R8, R12, R13, R15
*
*
         USING XR6,R6
EXO      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
XYEP     EQU   X'40'
XYSP     EQU   X'4A'
         DS    3F
         DS    26H
XYE      DS    10C
XYS      DS    10C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
KNY1T    BOX
         SR    R15,R15
         LA    R13,2
         SR    R12,R12
KNY11    LA    R8,0(R6,R15)
         TR    XYEP+1(1,R8),FFE
         LH    R7,XYE(R15)
         EX    0,FFFE(R7)
KNY1NY   TR    XYSP+1(1,R8),FFS
         LH    R7,XYS(R15)
         EX    0,FFFS(R7)
KNY1J    CR    R12,R13
         BC    8,NKNY1
         LR    R12,R13
KNY12    BXLE  R15,R13,KNY11
YKNY1    EQU   *
         MVI   CHAR,C'Y'
         BC    15,BEXIT5
KKNY1    EQU   *
         MVI   CHAR,C'K'
         BC    15,BEXIT5
NKNY1    EQU   *
         MVI   CHAR,C'N'
BEXIT5   BEXIT EXO
FFE      DS    0H
         DC    8X'00'
         DC     X'08'
         DC     2X'00'
         DC     X'04'
         DC     X'08'
         DC     2X'00'
         DC     X'04'
FFFE     DS     0F
         BC     15,KNY1NY
         BC     15,NKNY1
         BC     15,KKNY1
FFS      DS     0H
         DC     2X'00'
         DC     2X'04'
         DC     3X'00'
         DC     X'04'
         DC     8X'00'
FFFS     DS     0F
         BC     15,KNY12
         BC     15,KNY1J
         END
```

KVXYT

```
*FUNCTION
*
*DISTINGUISHES AMONG 2-STROKE (ALL VERT) K, V, X, AND Y BASED ON THE
*POSITIONS OF THE STARTING AND ENDING POINTS
*
*
*
*CALL
*         RCS   KVXYTA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7, R8, R12, R13, R15
*
*
         USING XR6,R6
EX0      EQU    0
         REGS
D6       DSECT
XR6      DS     0F
```

```
XYEP      EQU    X'40'
XYSP      EQU    X'4A'
          DS     3F
          DS     26H
XYE       DS     10C
          DS     10C
          DS     3F
          DS     1H
          DS     2C
          DS     3H
          DS     1C
CHAR      DS     1C
KVXYT     BOX
          SR     R15,R15
          LA     R13,2
          SR     R12,R12
KVXY1     LA     R8,0(R6,R15)
          TR     XYEP+1(1,R8),EEE
          LH     R7,XYE(R15)
          EX     0,EEEE(R7)
KXY       TM     XYSP+1(R8),X'03'
          BC     1,KKVXY
          BC     12,KVXY2
KVXY3     CR     R12,R13
          BC     8,VKVXY
          CR     R15,R13
          BC     8,XKVXY
          LR     R12,R13       SET J=1
KVXY2     BXLE   R15,R13,KVXY1
XKVXY     EQU    *
          MVI    CHAR,C'X'
          BC     15,BEXIT6
KKVXY     EQU    *
          MVI    CHAR,C'K'
          BC     15,BEXIT6
VKVXY     EQU    *
          MVI    CHAR,C'V'
          BC     15,BEXIT6
YKVXY     EQU    *
          MVI    CHAR,C'Y'
BEXIT6    BEXIT  EXO
EEE       DS     0H
          DC     X'08'
          DC     X'08'
          DC     X'08'
          DC     X'00'
          DC     X'08'
          DC     X'08'
          DC     X'08'
          DC     X'00'
          DC     X'08'
```

```
         DC    X'08'
         DC    X'08'
         DC    X'00'
         DC    X'04'
         DC    2X'0C'
         DC    X'00'
EEEE     DS    0F
         BC    15,KXY
         BC    15,KVXY2
         BC    15,YKVXY
         BC    15,KVXY3
         END
```

MWT

```
*FUNCTION
*
*DISTINGUISHES BETWEEN 3-STROKE (2 VERTS, 1 V-LIKE) OR 4-STROKE (ALL
*VERT) M AND W BASED ON THE POSITIONS OF THE ENDING POINTS
*
*
*
*CALL
*        RCS   MWTA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTERS
*
* C(R6) = ADDRESS OF THE TOP OF CHAREC'S INTERNAL PARAMETER LIST
*           (PASSED DOWN DIRECTLY FROM CHAREC , NOT SET SPECIFICALLY IN
*           REC)
* C(R13) = NO. OF STROKES - 1
*
*
*
*INTERNAL REGISTERS.  R8, R9, R11, R12, R15
*
*
         USING XR6,R6
EX0      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
XYEP     EQU   X'40'
```

```
         DS    3F
         DS    26H
XYE      DS    10C
         DS    10C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
MWT      BOX
         SR    R15,R15
         SR    R9,R9       J
         SR    R11,R11     K
         LA    R12,1
MW1IN    SLL   R15,1
         LA    R8,0(R6,R15)
         TR    XYEP+1(1,R8),GGE
         LH    R8,XYE(R15)
         EX    0,GGGE(R8)
MW11Q    LA    R9,1(0,R9)   J=J+1
         BC    15,MW1I
MW13Q    LA    R11,1(0,R11)
MW1I     SRL   R15,1
         BXLE  R15,R12,MW1IN
         CR    R9,R12
         BC    6,MWW
         CR    R11,R12     J=1
         BC    6,MWW  K NOT 1
MWM      EQU   *
         MVI   CHAR,C'M'
         BC    15,BEXIT4
MWW      EQU   *
         MVI   CHAR,C'W'
BEXIT4   BEXIT EXO
GGE      DS    0H
         DC    8X'04'
         DC    X'08'
         DC    2X'04'
         DC    X'00'
         DC    X'08'
         DC    X'04'
         DC    X'04'
         DC    X'00'
GGGE     DS    0F
         BC    15,MW11Q
         BC    15,MW1I
         BC    15,MW13Q
         END
```

PSTEST

```
*FUNCTION
*
*DISTINGUISHES AMONG COMMA, APOSTROPHE, AND NORMAL SIZE CHARACTERS.
*NORMAL SIZE IF ITS HEIGHT IS GREATER THAN 3/8 OF THE NORMALLY EXPECTED
*CHARACTER HEIGHT ('CHAREC' SETS DYM = 3/2 NORM CHAR HEIGHT).  COMMA IF
*TOP OF CHARACTER IS IN THE LOWER 5/8 OF A CHARACTER SPACE, OTHERWISE
*APOSTROPHE.  IF COMMA, CHARACTER CENTER IS SHIFTED UPWARD BY
*(NORMAL CHARACTER HEIGHT/4) RASTERS.
*
*
*
*CALL
*        RCS   PSTESTA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R8, R9, R15
*
*
         USING XR6,R6
EXO      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    17H
DYC      DS    1H
         DS    2H
YTC      DS    1H
         DS    5H
         DS    20C
WIDTH    DS    1H
HEIGHT   DS    1H
         DS    2F
         DS    1H
         DS    2C
         DS    3H
         DS    1C
CHAR     DS    1C
         DS    54C
         DS    14H
DYM      DS    1H
```

```
         DS    6H
CENT     DS    1F
PSTEST   BCX
         LH    R15,DYM
         SRL   R15,2  1/4 MAX DY
         CH    R15,DYC
         BC    4,PTX
         LH    R9,YTC
         SRL   R9,2  YTC IN RASTERS
         LH    R15,HEIGHT
         SRL   R15,2                   HEIGHT IN RASTERS
         SR    R8,R8
         DR    R8,R15                  R8=REM(YTC/HEIGHT)
         SRL   R15,1                   1/2 HEIGHT
         LR    R9,R15
         SRL   R9,2                    1/8 HEIGHT
         AR    R15,R9                  5/8 HEIGHT
         CR    R8,R15
         BC    2,PTA
*REM(YTC/HEIGHT) LSS, EQ 5/8 HEIGHT
         MVI   CHAR,X'EB'
*SHIFT CENTER OF COMMA UP BY HEIGHT/4 RASTERS
         L     R8,CENT
         LH    R15,HEIGHT
         SRL   R15,2
         AR    R8,R15
         ST    R8,CENT
         BC    15,PTX
*REM(YTC/HEIGHT) GTR 5/8 HEIGHT
PTA      MVI   CHAR,X'FD'
PTX      BEXIT EXO
         END
```

SYMT

```
*FUNCTION
*
*RECOGNIZES GEOMETRIC SYMBOLS BASED FIRSTLY ON THE NO. OF TIMES EACH
*16-DIRECTION (THE SAME AS THE DIRECTIONS IN THE INK TRACK) OCCURS,
*THEN ON NO. OF TIME-CORNERS, THE 4-DIRECTION SEQUENCE, SEPARATION BET-
*WEEN STARTING AND ENDING POINTS, AND ASPECT RATIO.
*
*
*
*CALL
*        RCS   SYMTA,ENDCHAR,ECHAR
```

```
*EXIT NOCHAR WHEN THE SYMBOL IS NOT ONE OF THE GEOMETRIC SYMBOLS
*EXIT CHAR WHEN A GEOMETRIC SYMBOL IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7-R13, R15
*
*
          USING XR6,R6
EX0       EQU   0
EX4       EQU   4
          REGS
D6        DSECT
XR6       DS    0F
          DS    2F
CODE      DS    1F
          DS    10H
N         DS    1H
          DS    5H
DXC       DS    1H
DYC       DS    1H
          DS    8H
          DS    20C
          DS    3F
          DS    1H
          DS    2C
NCUSP     DS    1H
          DS    2H
          DS    1C
CHAR      DS    1C
          DS    6C
XSP       DS    10C
YSP       DS    10C
XEP       DS    10C
YEP       DS    10C
          DS   8C
          DS    21H
          DS    1F
          DS    6C
          DS    1H
          DS    1F
          DS    20C
D0        DS    1H
D1        DS    1H
          DS    2H
D4        DS    1H
          DS    2H
D7        DS    1H
D8        DS    1H
```

```
D9       DS    1H
         DS    2H
D12      DS    1H
         DS    2H
D15      DS    1H
DN       DS    1H
NTCUSP   DS    1H
SYMT     BOX
         SR    R8,R8
         LH    R9,DN
         LA    R15,5
         DR    R8,R15
         LR    R12,R9
         LH    R13,DN
         LR    R15,R13
         SRL   R15,2
         SR    R13,R15
*C(R12)  =0.2(NO. OF DIRECTION OCCURANCES)
*C(R13)  =0.75(NO. OF DIRECTION OCCURANCES)
*IS NO.   OF HORIZ GTR 0.2 DN?
         LH    R7,D0
         AH    R7,D8
         CR    R7,R12
         BC    2,BOXTRI      YES
*NO, IS   NO. OF HORIZ IN 1 DIRECTION GTR
*1/8 DN  ?
         LH    R8,DN
         SRL   R8,3
*NEARLY RIGHT-DIRECTION
         LH    R7,D15
         CR    R7,R8
         BC    2,RIGHT
         LA    R10,2
         SR    R9,R9
         LA    R11,2
NEARR    LH    R7,D0(R9)
         CR    R7,R8
         BC    2,RIGHT
         BXLE  R9,R10,NEARR
         LA    R11,18
         CR    R9,R11
         BC    10,NOTSQ
*NEARLY LEFT-DIRECTION
         LA    R9,14
         B     NEARR
*NO
*IS NO.   OF 4 MAIN DIRECTIONS LESS THAN 1/8 DN?
NOTSQ    LH    R7,D0
         AH    R7,D8
         AH    R7,D4
         AH    R7,D12
         LH    R9,DN
         SRL   R9,3
         CR    R7,R9
         BC    4,PBOXX       YES
*NO, IS   IT GTR 0.2 DN?
         CR    R7,R12
         BC    2,ROUND       YES
         LA    R10,256
         BC    15,ROUND
*IS NO.   OF 4 MAIN DIRECTIONS AT LEAST
*3/4 DN  ?
BOXTRI   AH    R7,D4
         AH    R7,D12
         CR    R7,R13
         BC    10,BOXX       YES
*NO, IS   NO. OF VERTS GTR 1/4 DN?
         LH    R9,DN
         SRL   R9,2
         LH    R7,D4
         AH    R7,D12
         CR    R7,R9
         BC    2,BOXX
*NO
*IS NO.   IN 1 HORIZONTAL DIRECTION
*PLUS 2   OTHER DIRECTIONS AT LEAST 3/4 DN?
*FIRST   FIND HORIZ. DIRECTION
         LH    R7,D0
         CR    R7,R12
         BC    10,RIGHT
         LH    R7,D8
         CR    R7,R12
         BC    4,ROUND
*R7 HAS   NO. OF RIGHTS OR LEFTS
*FIND D  OWNWARD DIRECTION
RIGHT    LA    R9,20
         LA    R10,2
         LA    R11,30
DOWN     LH    R8,D0(R9)
         AH    R8,D0-2(R9)
         CR    R8,R12
         BC    10,DOWNX
         BXLE  R9,R10,DOWN
*NO SUC  H DOWNWARD DIRECTION
         BC    15,ROUND
*R9 CON  TAINS DOWNWARD DIRECTION CODE
*R8 CON  TAINS NO, OF DOWNWARDS
*FIND U  PWARD DIRECTION DIRECTION
DOWNX    AR    R7,R8
         LA    R15,24
         CR    R9,R15
         BC    2,DGTR12
         BC    4,DLSS12
*DOWNWA  RD DIRECTION IS 12
*UP DIR  ECTICN MUST BE 3,4, OR 5
         LA    R9,6
         LA    R11,10
         BC    15,UP
*DOWN D  IR. IS 10 OR 11
**UP DI  R. MUST BE 4,5,OR 6
DLSS12   LA    R9,8
         LA    R11,12
         BC    15,UP
*DOWN D  IR. IS 13 OR 14
*UP DIR  . MUST BE 2,3,OR4
DGTR12   LA    R9,4
         LA    R11,8
*FIND U  P DIRECTION
UP       LH    R8,D0(R9)
         AH    R8,D0+2(R9)
         CR    R8,R12
         BC    10,UPX
         BXLE  R9,R10,UP
*NO SUC  H UPWARD DIRECTION
         BC    15,ROUND
*R7 CON  TAINS NO. OF HORIZS. ? DOWNS
*R8 CON  TAINS NO, OF UPWARDS
*IS TOT  AL HORIZ, UPS, AND DOWNS
*GREATE  R THAN 3/4 DN?
UPX      AR    R7,R8
         CR    R7,R13
         BC    12,NOTSQ
*TRIANGLE, TRAPAZOID, OR ELLIPSE
*TRIANGLE IF HORIZ NOT GTR 0.375 DN
         LH    R7,D0
         AH    R7,D8
         LR    R15,R13
         SRL   R15,1                    0.375 DN
         CR    R7,R15
         BC    12,TRIX
*CHECK TIME CORNERS FOR TRAP
         CLI NTCUSP+1,X'02'
         BC    2,TRAPXX
         B     ELPSX
*SYMBOL   NCT BOX OR TRIANGLE
*TEST F  OR CIRCLE OR ELLIPSE
*CR TRAPAZOID
*4-ANGL  E SEQUENCE MUST BE
*0-3-2-  1 OR 2-3-0-1
ROUND    CLI   CODE,X'B1'
         BC    8,OKSYM
         CLI   CODE,X'39'
         BC    8,OKSYM
```

```
*3-2-1-  0
         CLI   CODE,X'E4'
         BC    8,OKSYM
*2-1-0-  3
         CLI   CODE,X'93'
         BC    8,OKSYM
*1-0-3-  2
         CLI   CODE,X'4E'
         BC    8,OKSYM
*3-0-1-  2
         CLI   CODE,X'C6'
         BC    8,OKSYM
*0-1-2-  3
         CLI   CODE,X'1B'
         BC    8,OKSYM
*1-2-3-  0
         CLI   CODE,X'6C'
         BC    8,OKSYM
*IS THI  S A POTENTIAL PBOX?
         LA    R9,256
         CR    R9,R10
         BC    8,PBOXX
*TEST FOR NARROW TRAPEZOID
*NO MORE THAN 4 ANGLES
*MOSTLY HORIZONTAL
*CLOSE ENDPOINTS
         CLI   N+1,X'04'
         BC    2,NOSYMX
         LH    R7,D0
         AH    R7,D1
         AH    R7,D15
         AH    R7,D8
         AH    R7,D7
         AH    R7,D9
         LH    R9,DN
         SRL   R9,1
         CR    R7,R9
         BC    4,NOSYMX
         CLI   NTCUSP+1,X'02'
         BC    12,XELPS
         LA    R10,128
         BC    15,PBOXX
*DECIDE IF ELLIPSE
*ARE ENDPOINTS SEPARATED VERTICALLY
XELPS    LH    R7,YSP
         SH    R7,YEP
         LPR   R7,R7
         SLL   R7,1
         CH    R7,DYC
         BC    4,ELPSX
NOSYMX   BEXIT EXO
```

```
*DECIDE   BETWEEN CIRCLE AND ELLIPSE
*AND TRAPAZOIC
CKSYM    CLI   NTCUSP+1,X'02'
         BC    2,TRAPXX
         LH    R7,DYC
         SLL   R7,1
         CH    R7,DXC
         BC    2,CIRCX
ELPSX    EQU   *
         MVI   CHAR,X'76'
         BC    15,BEXIT7
BOXX     EQU   *
         MVI   CHAR,X'73'
         BC    15,BEXIT7
CIRCX    EQU   *
         MVI   CHAR,X'74'
         BC    15,BEXIT7
TRIX     EQU   *
         MVI   CHAR,X'75'
         BC    15,BEXIT7
TRAPXX   EQU   *
         MVI   CHAR,X'78'
         BC    15,BEXIT7
*TEST F  OR CLOSENESS OF ENDPTS
PBOXX    LH    R7,XSP
         SH    R7,XEP
         LPR   R7,R7
         SLL   R7,1
         CH    R7,DXC
         BC    2,NOSYMX
         LH    R7,YSP
         SH    R7,YEP
         LPR   R7,R7
         SLL   R7,1
         CH    R7,DYC
         BC    2,NOSYMX
         LA    R9,128
         CR    R9,R10
         BC    8,TRAPXX
XXPBOX   EQU   *
         MVI   CHAR,X'77'
BEXIT7   BEXIT EX4
         END
```

TILDT

```
*FUNCTION
*
*RECOGNIZES TILDA BASED ON CHAR. HEIGHT, ASPECT RATIO, AND FIRST FOUR
*DIRECTIONS.
*ALTHOUGH THIS ROUTINE ENCORPORATES ALL THE CODE FOR RECOGNITION, IT
*PRESENTLY ALWAYS TAKES THE NOT TILDA EXIT.
*
*
*
*CALL
*        RCS   TILDTA,ENOTTIL,ETIL
*EXIT NOTTIL WHEN THE CHARACTER IS NOT A TILDA
*EXIT TIL WHEN THE CHARACTER IS A TILDA
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTER.  R7
*
*
         USING XR6,R6
EX0      EQU   0
EX4      EQU   4
         REGS
D6       DSECT
XR6      DS    0F
         DS    2F
CODE     DS    1F
         DS    17H
DYC      DS    1H
         DS    4H
ASPR     DS    1H
         DS    3H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
P        DS    1C
CHAR     DS    1C
         DS    54C
         DS    14H
DYM      DS    1H
TILDT    BOX
         LH    R7,DYM
         SRL   R7,2           1/4 DYM
         CH    R7,DYC
         BC    4,NOTIL
*DYC LE  SS THAN 1/4 DYM
         CLI   ASPR+1,X'02'
         BC    2,NOTIL
         CLI   ASPR+1,X'01'
         BC    4,NOTIL
* ASPEC  T RATIO IS BETWEEN 1/2 AND 1/4
*TEST F  OR ALLOWABLE SEQUENCES
*0-0-0-  0
         CLI   CODE,X'C0'
         BC    8,TIL
*0-3-0-  0
         CLI   CODE,X'30'
         BC    8,TIL
*0-3-0-  1
         CLI   CODE,X'31'
         BC    8,TIL
*1-0-0-  0
         CLI   CODE,X'40'
         BC    8,TIL
*1-0-1-  1
         CLI   CODE,X'45'
         BC    8,TIL
*1-0-3-  0
         CLI   CODE,X'4C'
         BC    8,TIL
*1-0-3-  1
         CLI   CODE,X'4D'
         BC    8,TIL
*1-3-0-  0
         CLI   CODE,X'70'
         BC    8,TIL
*1-3-0-  1
         CLI   CODE,X'71'
         BC    8,TIL
*1-3-1-  1
         CLI   CODE,X'75'
         BC    8,TIL
NCTIL    BEXIT EXO
*TEMPOR  ARILY KILL TILDA
TIL      BC    15,NOTIL
         MVI   P,X'02'
TILX     EQU   *
         MVI   CHAR,X'D0'
         BEXIT EX4
         END
```

TPXY

```
*FUNCTION
*
*DISTINGUISHES AMONG 2-STROKE (1 VERT, 1 HORIZ) T, X, Y, AND PLUS BASED
*ON THE POSITIONS OF STARTING AND ENDING POINTS
*
*
*
*CALL
*        RCS   TPXYA,ECHAR
*EXIT CHAR WHEN A CHARACTER IS RECOGNIZED
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  R7-R9, R12, R13, R15
*
*
         USING XR6,R6
EXO      EQU   0
         REGS
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    26H
XYE      DS    10C
         DS    10C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
P        DS    1C
CHAR     DS    1C
XYEP     EQU   X'40'
XYSP     EQU   X'4A'
TPXY     BOX
*IS SECOND STROKE HORIZONTAL?
         CLI   P,X'02'
         BC    8,YES
         LA    R9,2(R6)                VERT REF
         B     GO
YES      LA    R9,0(R6)                VERT REF
GO       EQU   *
         SR    R15,R15
         SR    R12,R12
         LA    R13,2
TPLUS1   LA    R7,0(R6,R15)
         LH    R8,XYEP(R7)
         STH   R8,XYE+4
         TR    XYE+5(1),TTE
         LH    R8,XYE+4
```

```
          EX     0,TTTE(R8)
TPLUS4    TM     XYSP+1(R7),X'0C'
          BC     8,TPLS1  YS GTR 3/4 DELTA Y
          BC     1,TPLUS2  YS LESS 1/4 DELTA Y
*START    IN MIDDLE Y
          TM     XYSP+1(R7),X'08'
          BC     1,TPLUS5
          TM     XYEP+1(R7),X'0C'
          BC     9,TPLUS2
          BC     4,PTPXY
*START    IN LOWER MID Y
TPLUS5    TM     XYEP+1(R7),X'0C'
          BC     1,TPLUS2
          BC     12,PTPXY
*START    AT TOP
TPLS1     TM     XYEP+1(R7),X'0C'
          BC     8,TTPXY
          BC     4,TPLUS3
*END AT    BOTTOM
          TM     XYEP+1(R7),X'03'
          BC     1,TPLUSX  LEFT
          BC     8,XTPXY  RIGHT
          BC     4,TPLUS2  MIDDLE
*START    AT TOP, END IN MIDDLE Y
*IS END    IN RIGHT MID Y?
TPLUS3    TM     XYEP+1(R7),X'03'
          BC     5,TPLUS2
*YES
          TM     XYEP+1(R7),X'80'
          BC     1,XTPXY
          CR     R12,R13
          BC     8,YTPXY
          BC     6,TPLUS2
TPLUSX    LR     R12,R13
TPLUS2    BXLE   R15,R13,TPLUS1
          CR     R12,R13
          BC     8,XTPXY
TTPXY     EQU    *
*IS VERT  START  IN UPPER LEFT
          CLI    XYSP+1(R9),X'C0'
          BC     8,YTPXY
          MVI    CHAR,C'T'
          BC     15,BEXIT3
PTPXY     EQU    *
*IS VERT  START  IN UPPER LEFT
          CLI    XYSP+1(R9),X'C0'
          BC     8,YTPXY
          MVI    CHAR,X'CE'
          BC     15,BEXIT3
XTPXY     EQU    *
          MVI    CHAR,C'X'
```

```
         BC     15,BEXIT3
YTPXY    EQU    *
         MVI    CHAR,C'Y'
BEXIT3   BEXIT  EXO
TTE      DS     0H
         DC     X'00'
         DC     2X'04'
         DC     X'00'
         DC     X'10'
         DC     2X'04'
         DC     X'08'
         DC     X'10'
         DC     2X'04'
         DC     X'10'
         DC     X'0C'
         DC     3X'10'
TTTE     DS     0F
         BC     15,TTPXY
         BC     15,YTPXY
         BC     15,PTPXY
         BC     15,XTPXY
         BC     15,TPLUS4
         END
```

VERTST

```
*FUNCTION
*
*DETERMINES THE SET OF STROKE TYPES WHEN THE MOST RECENT STROKE IS A
*VERTICAL.  BASED ON 'P' AND THE NO. OF STROKES
*
*
*
*CALL
*         RCS   VERTSTA,EV1,EV2,EV1H1,EV1NOT
*EXIT V1 WHEN THERE IS ONLY ONE VERTICAL STROKE (THE MOST RECENT)
*EXIT V2 WHEN THERE ARE 2 VERTICAL STROKES
*EXIT V1H1 WHEN THERE IS 1 VERT STROKE AND 1 HORIZ STROKE
*EXIT V1NOT WHEN THERE IS 1 VERT STROKE AND THE PREVIOUS SUBCHARACTER
* IS NEITHER VERT OR HORIZ
*
*
*
*INPUT REGISTER.  R6
*
*INTERNAL REGISTERS.  NONE
```

```
*
*
*
         USING XR6,R6
EX0      EQU   0
EX12     EQU   12
EX4      EQU   4
EX8      EQU   8
         REGS
D6       DSECT
XR6      DS    0F
         DS    3F
         DS    11H
SN       DS    1H
         DS    14H
         DS    20C
         DS    3F
         DS    1H
         DS    2C
         DS    3H
P        DS    1C
VERTST   BOX
         CLI   P,X'02'
         BC    8,EQ2
         BC    2,GTR2
LSS2     CLI   P,X'01'
         BC    8,EQ1
LSS1     CLI   SN+1,X'01'
         BC    2,GTR2          SN>1
         MVI   P,X'01'
         BEXIT EX0
EQ1      MVI   P,X'00'
         BEXIT EX4
EQ2      MVI   P,X'00'
         BEXIT EX8
GTR2     MVI   P,X'01'
         BEXIT EX12
         END
```

APPENDIX

THE OS/360 OPERATING SYSTEM--2250 DISPLAY RECOGNITION PROGRAM

In order to modify the GRAIL recognition program for operation under OS/360 and in conjunction with a 2250 display, only CHAREC and the macros need be changed:

The following changes must be made for the program to operate under OS/360:

1) Either the GRAIL macros (see MACROS below) must be modified so that they do not require the SVC (supervisor call) command, or the GRAIL SVC's must be built into OS/360. The GRAIL SVC's are used to initiate and terminate processes, synchronize parallel processes, go to the wait state, etc., and may be replaced by the equivalent code. The macros must be added to the macro library.
2) CHAREC must be modified to await the asynchronous event of either a pendown or the expiration of the real-time interval timer. This is done by first issuing a STIMER OS/360 macro and then a WAIT OS/360 macro for the Tablet pen. If the timer expires, the ECB (Event Control Block) for the WAIT is posted with a special code and control is returned to the system. When control is returned from the WAIT, the special code is checked to see if it was posted by the timer; if not, the timer is cancelled and the pendown is processed.

The following changes must be made for the program to operate in conjunction with a 2250 display:

1) CHAREC must be modified to do its inking on the 2250. This involves formatting the x,y coordinates and writing them into the 2250 buffer. The method of erasing the ink track must similarly be modified

2) The character codes (see CRT Display Character Codes below) must be converted to EBCDIC (Extended Binary-Coded-Decimal Interchange Code). This may be done either in CHAREC prior to outputting a code, or externally to the recognition program.

CRT DISPLAY CHARACTER CODES

Upper-Case	
Letter	Hex Code
A	C1
B	C2
C	C3
D	C4
E	C5
F	C6
G	C7
H	C8
I	C9
J	D1
K	D2
L	D3
M	D4
N	D5
O	D6
P	D7
Q	D8
R	D9
S	E2
T	E3
U	E4
V	E5
W	E6
X	E7
Y	E8
Z	E9

Lower-Case	
Letter	Hex Code
A	81
B	82
C	83
D	84
E	85
F	86
G	87
H	88
I	89
J	91
K	92
L	93
M	94
N	95
O	96
P	97
Q	98
R	99
S	A2
T	A3
U	A4
V	A5
W	A6
X	A7
Y	A8
Z	A9

Punctuation	
Symbol	Hex Code
+	CE
-	E0
=	FE
/	E1
(	CD
)	DD
*	DC
$	DB
.	CB
,	EB
'	FD
#	FB
[	CF
]	DF
<	CC
>	EE
^	70
~	D0

Special	
Symbol	Hex Code
Erasure	72
Cannot Inter-pret	EF

Geometric	
Symbol	Hex Code
▭	73
○	74
▽	75
⬭	76
◇	77
⏢	78

Numbers	
Number	Hex Code
0	F0
1	F1
2	F2
3	F3
4	F4
5	F5
6	F6
7	F7
8	F8
9	F9

REGISTER ASSIGNMENT

Registers are referred to as RO, Rl, ..., R15, rather than as 0, 1, ..., 15. The equivalence is made by the macro REGS (see MACROS below).

Rl through R5 have special system assignments:

Rl is the contextual base-register.

R2 is the read-only code base-register.

R3 is the data base-register for data defined within a given context.

R4 is an address argument register, and is used in process calls.

R5 is used in macro and process calls, and as the address argument register for SS instructions with two formal parameters.

R6 has a special assignment in REC and the RCS's--it is locally loaded by REC to reference DSECT type label descriptions of CHAREC's data.

PROCESSES

CHAR

CHAR is an interface process between a Tablet input device and the recognition program on one side, and an application program on the other. It allows its parent process (the application program) to interact with the Tablet by providing a convenient level of control. In addition to providing CHAREC outputs (see CHAREC outputs below), CHAR provides the raw Tablet data to the user. CHAR is a read-only reentrant process that uses two other read-only processes--CHAREC (see p. 20), a reentrant process, and TABLET, a serially re-usable process (i.e., each use must wait for the hardware device to be free), which communicates with the Tablet.

CHAR allows the following user controls:

Permit/inhibit inking (stylus tracking) by CHAREC.
Permit/inhibit character recognition.
Permit/inhibit halting CHAREC.
Permit/inhibit providing raw data to either CHAREC, or the user.
Specify ink vector length.

CHAR has the following parallel task exits:

Match (coincidence of the virtual tablet stylus and displayed data) detected--similar to a light pen strike.
Keyboard character detected (for optional keyboard device).
Penup detected.
Raw data buffer filled.
Character recognized.
Character not recognized.

CHAR has the following terminal exits:

Normal termination exit.
Error exit (channel multiplex or device error).

CLOCK

Function. This process acts as a real-time clock that is turned off (takes the terminal turned-off exit) by CHAREC as a result of a pendown, or sets an alarm (takes the expired parallel task exit) if the 360 real-time clock runs longer than a prespecified time before a pendown occurs.

Call.

```
INST  ACLK,CLKA,FWAITBX,ITIME,EEXP,ETOFF
```

ACLK is a linkage between CHAREC's context and
  CLOCK's context.
CLKA is a link to CLOCK.
WAITBX is CHAREC's PSG.
TIME is the time at which CLOCK takes the expired exit.
Exit EXP is the expired (parallel) exit.
Exit TOFF is the turned-off (terminal) exit.

MACROS

BEXIT

```
*FUNCTION
*
*RETURN FROM A REMOTE CODE SEQUENCE
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     BEXIT   &EXIT
&LABEL   L     R2,4(R1)
           EX      C,&EXIT.(R5)
           MEND
```

BOX

```
*FUNCTION
*
*INITIATES A REMOTE CODE SEQUENCE
*
*
*
*MACRO DEFINITION
*
         MACRO
&LABEL     BOX
&LABEL     CSECT
           USING   *,R2
           MEND
*
```

CLEAR

```
*FUNCTION
*
*PARALLEL PROCESS SYNCHRONIZER. NULLIFIES THE ADVENT OF 'WATE' AND/OR
*'SET'
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     CLEAR   &CNTX=I,&PSG=0
           AIF     ('&CNTX' EQ 'I').A
&LABEL     L       R5,&PSG
         TM    0(R5),X'01'
         BC    8,*+6
         SVC   CRW
           NI      0(R5),X'7E'
           MEXIT
.A         ANOP
&LABEL   LA    R5,&PSG
         TM    0(R5),X'01'
         BC    8,*+6
         SVC   CRW
         NI    0(R5),X'7E'
           MEND
```

EPLOG (Epilogue)

```
*FUNCTION
*
*TERMINATES A PROCESS
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL   EPLOG &EXIT,&STATE,&PSW,&ENTER
&LABEL   LA    R5,&EXIT
```

```
         AIF   ('&STATE' EQ 'S').B
           SVC     RETURN
         MEXIT
.B       ANOP
           LA      R6,&PSW
         LA    R7,&ENTER
           SVC     RETSUP
           MEND
```

INST (Instance)

```
*FUNCTION
*
*
*GENERATES THE CALLING SEQUENCE FOR A RE-ENTRANT PROCESS
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     INST    &CNTX,&LOCN,&A1,&A2,&A3,&A4,&A5,&A6,&A7,&A8,&A9,&A10X
               ,&A11,&A12,&A13,&A14,&A15,&A16,&A17,&A18,&A19,&A20,&A21,X
               &A22,&A23,&A24,&A25,&A26,&A27,&A28,&A29,&A30,&A31,&A32,&X
               A33,&A34,&A35,&A36,&A37,&A38,&A39,&A40,&A41,&A42,&A43,&AX
               44,&A45,&A46
         LCLA  &AL1,&AL2,&AL3,&AL4
         LCLC  &CG1,&CG2,&CG3
&LABEL   LA    R4,&CNTX
           LA      R5,&LOCN
           SVC     FORMAL
&CG3     SETC  '        '
&AL1       SETA    2
&AL2       SETA    6
&AL3       SETA    1
.A         ANOP
&AL1       SETA    &AL1+1
&AL2       SETA    &AL2+1
&CG1       SETC    '&SYSLIST(&AL1)'(1,1)
&CG2     SETC  '&SYSLIST(&AL1).&CG3'(2,8)
           AIF     ('&CG1' NE 'E').E
&AL3       SETA    0
           AIF     (&AL1 GT 3).G
.F         ANOP
&AL4       SETA    &AL1-3
&AL4       SETA    &AL4*4
```

```
           LA      R7,GS&SYSNDX
           ST      R7,&AL4.(R6)
           ST      R4,&CNTX
           BR      R5
GS&SYSNDX      B      &CG2
.Y         ANOP
&AL1       SETA    &AL1+1
           AIF     ('&SYSLIST(&AL1)' EQ '').W
&CG2     SETC  '&SYSLIST(&AL1).&CG3'(2,8)
         B     &CG2
           AGOB    .Y
.W         ANOP
           MEXIT
.E         AIF     (&AL2 LE 15).B
.G         ANOP
&AL2       SETA    &AL2-1
&AL4       SETA    &AL1-3
&AL4       SETA    &AL4-&AL2+6
           AIF     (&AL1 GT 12).X
&AL4     SETA  0
.X       ANOP
&AL4       SETA    &AL4*4
           STM     R7,R&AL2,&AL4.(R6)
&AL2       SETA    7
           AIFB    (&AL3 EQ 0).F
.B         ANOP
           AIF     ('&CG1' EQ 'I').C
           L       R&AL2,&CG2
           AGOB    .A
.C         ANOP
           LA      R&AL2,&CG2
           AGOB    .A
           MEND
```

PARL (Parallel)

```
*FUNCTION
*
*INITIATES A PARALLEL PROCESS.  THIS PROCESS FIRST TAKES THE HIGH
*PRIORITY EXIT.  WHEN THE HIGH PRIORITY TASK IS COMPLETED OR SUSPENDED,
*THIS PROCESS TAKES THE LOW PRIORITY EXIT.
*
*
*
*MACRO DEFINITION
*
```

```
           MACRO
&LABEL     PARL    &CNTX=I,&LOW=0,&HIGH=0,&STATE=0,&PSW=0
           AIF     ('&CNTX' EQ 'F').A
&LABEL   SVC   PARIN
           B       &LOW
           B       &HIGH
           MEXIT
.A         ANOP
&LABEL   SVC   PARLEL
         B     &LOW
           LH      R5,10(R2)
           BCT     R5,*+4
           SLL     R5,2
           L       R5,0(R5,R1)
         AIF   ('&STATE' NE '0').B
         L     R1,0(R1)
         LM    R2,R3,4(R1)
           EX      0,&HIGH.(R5)
         MEXIT
.B         LA      R5,&HIGH.(R5)
           ST      R5,&PSW+4
           LA      R5,&PSW
         L     R1,0(R1)
         LM    R2,R3,4(R1)
           LPSW    0(R5)
         MEND
```

PAWS (Pause)

```
*FUNCTION
*
*TERMINATES A FLOW OF CONTROL. RESULTS IN INITIATING THE NEXT TASK ON
*THE SUPERVISOR TASK LIST, WHICH, IF THE ONLY TASK, WILL BE THE WAIT
*STATE WITH TRAPS ENABLED.
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     PAWS
&LABEL     SVC     PAUSE
           MEND
*
*
```

PROCS (Process)

```
*FUNCTION
*
*SETS UP THE PROCESS ENTRY POINT, ITS IDENTIFICATION NUMBER, AND ITS
*STORAGE REQUIREMENTS
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     PROCS    &CLEAR=3,&CNTX=3,&AUTO=0,&ID=80000000,&PROLG=0
&LABEL     CSECT
           USING    *,R2
         LM     R2,R3,4(R4)
           B        &PROLG
           DC       H'&CLEAR'
           DC       H'&CNTX'
           DC       H'0'
           DC       H'&AUTO'
           DC       X'&ID'
           MEND
```

PROLG (Prologue)

```
*FUNCTION
*
*INITIATES A PROCESS--PRECONDITIONS CERTAIN VALUES
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL    PROLG      &AUTO=YES,&STATE=0,&PSG=0,&LINK=0
  AIF  ('&AUTO' EQ '0').A
&LABEL   DS     0H
           LR       R1,R4
         AIF    ('&STATE' EQ '0').B
         LA     R4,&PSG
         LA     R5,&LINK
         SVC   SUPER
.B       MEXIT
.A         ANOP
&LABEL   DS    0H
         LR    R1,R4
           AIF     ('&STATE' EQ '0').C
           SVC     SUPER
.C         MEXIT
           MEND
```

<u>RCS</u> (Remote Code Sequence)

```
*FUNCTION
*
*GENERATES THE CALLING SEQUENCE FOR A REMOTE CODE SEQUENCE--A PROCESS
*WITH ONLY REGISTER I/O WHICH OPERATES IN THE ENVIRONMENT OF THE PARENT
*(CALLING) CONTEXT
*
*
*
*MACRO DEFINITION
*
           MACRO
&NAME      RCS     &LABEL,&A6,&A7,&A8,&A9,&A10,&A11,&A12,&A13,&A14,&A15X
               ,&A0,&E1,&E2,&E3,&E4,&E5,&E6,&E7,&E8,&E9,&E10,&E11,&E12
         LCLA  &AL1,&AL2,&AL3
         LCLC  &CG1,&CG2,&CG3
&NAME      DS      0H
&AL1       SETA    1
&AL3     SETA  0
&CG3     SETC  '       '
.D         ANOP
&AL1       SETA    &AL1+1
&AL2       SETA    &AL1+4
&AL3     SETA  &AL3+1
           AIF     ('&SYSLIST(&AL1)' EQ '').A
&CG1       SETC    '&SYSLIST(&AL1)'(1,1)
&CG2     SETC  '&SYSLIST(&AL1).&CG3'(2,8)
           AIF     ('&CG1' EQ 'E').C
           AIF     ('&CG1' EQ 'I').B
         L     R&AL2,&CG2
           AGOB    .D
.B         LA      R&AL2,&CG2
           AGOB    .D
.A     AIF     (&AL3 EQ 15).C
         AGOB  .D
```

```
.C     L       R2,&LABEL
           BALR    R5,R2
.Y       B     &CG2
&AL1       SETA    &AL1+1
           AIF     ('&SYSLIST(&AL1)' EQ '').W
&CG2     SETC  '&SYSLIST(&AL1).&CG3'(2,8)
           AGOB    .Y
.W         ANOP
           MEND
```

REGS (Registers)

```
*FUNCTION
*
*GENERATES THE CODE  R0 EQU 0, R1 EQU 1, . . ., R15 EQU 15
*THE SYMBOLIC FORM IS USED BY THE OTHER MACROS
*
*
*
*MACRO DEFINITION
*
           MACRO
&NAME      REGS
R0         EQU     0
R1         EQU     1
R2         EQU     2
R3         EQU     3
R4         EQU     4
R5         EQU     5
R6         EQU     6
R7         EQU     7
R8         EQU     8
R9         EQU     9
R10        EQU     10
R11        EQU     11
R12        EQU     12
R13        EQU     13
R14        EQU     14
R15        EQU     15
           MEND
```

SET

```
*FUNCTION
*
*PARALLEL PROCESS SYNCHRONIZER--DENOTES AN EVENT HAS OCCURED
*RESULTS IN SUPERVISOR STACKING A 'WAIT'ED TASK ON THE SUPERVISOR TASK
*LIST IF IN THE WAIT STATE
*
*
*
*MACRO DEFINITION
*
           MACRO
&LABEL     SET       &CNTX=I,&PSG=0
           AIF       ('&CNTX' EQ 'I').B
&LABEL     L         R5,&PSG
           AGO       .A
.B         ANOP
&LABEL     LA        R5,&PSG
.A         TM        0(R5),X'01'
           BO        GS&SYSNDX
           OI        0(R5),X'80'
           B         GS&SYSNDX+2
GS&SYSNDX  SVC       STACK
           MEND
```

SVCS

```
*FUNCTION
*
*DEFINES PARAMETERS FOR MACROS
*
*
*
*MACRO DEFINITION
*
           MACRO
&NAME      SVCS
STACK    EQU   5
WAIT     EQU   6
OCUPID   EQU   7
FORMAL   EQU   8
AUTO     EQU   9
CRW      EQU   20
RETURN   EQU   15
PARIN    EQU   21
PARLEL   EQU   16
PAUSE    EQU   17
           MEND
```

TABLE

```
*FUNCTION
*
*PERFORMS SEQUENCES OF TESTS ON ENCODED 1-BYTE FEATURES
*
*
*
*
*MACRO DEFINITION
*
         MACRO
&LABEL   TABLE &A1,&A2,&A3,&A4,&A5,&A6,&A7,&A8,&A9,&A10,&A11,&A12,&A13,X
               &A14,&A15,&A16,&A17,&A18,&A19,&A20,&A21,&A22,&A23,&A24,&X
               A25,&A26,&A27,&A28,&A29,&A30,&A31,&A32,&A33,&A34,&A35,&AX
               36,&A37,&A38,&A39,&A40,&A41,&A42,&A43,&A44,&A45,&A46,&A4X
               7,&A48,&A49
         LCLA  &AL1,&AL2
         LCLC  &CG1,&CG2,&CG3,&CG4,&CG5
         AIF   ('&LABEL' EQ '').D
&LABEL   EQU   *
.D       ANOP
&AL1     SETA  0
.A       ANOP
&AL1     SETA  &AL1+1
         AIF   ('&SYSLIST(&AL1)' NE '').B
         MEXIT
.B       ANOP
&CG1     SETC  '&SYSLIST(&AL1)'(1,1)
         AIF   ('&CG1' GT 'Z').C
&CG2     SETC  'AL1('
&CG3     SETC  ')'
&CG4     SETC  '&SYSLIST(&AL1)'(2,2)
         AIF   ('&CG4' EQ 'EX').E
         DC    &CG2&CG4&CG3
&AL1     SETA  &AL1+2
&CG2     SETC  'X'''
&CG3     SETC  ''''
&CG4     SETC  '&SYSLIST(&AL1)'(1,2)
         DC    &CG2&CG4&CG3
&AL1     SETA  &AL1-1
&CG2     SETC  'AL1('
&CG3      SETC   ')'
&CG4      SETC   '-DATA'
          DC     &CG2&SYSLIST(&AL1)&CG4&CG3
&AL1      SETA   &AL1+1
          AGOB   .A
.C        ANOP
&AL2      SETA   4096*&SYSLIST(&AL1)
&CG2      SETC   '+'
&CG3      SETC   '-BASE'
&CG4      SETC   'AL2('
&CG5      SETC   ')'
&AL1      SETA   &AL1+1
          DC     &CG4&AL2&CG2&SYSLIST(&AL1)&CG3&CG5
          AGOB   .A
.E        ANOP
&CG5      SETC   'AL1('
&AL1      SETA   &AL1+1
          DC     &CG2&CG4&CG3
          DC     &CG5&SYSLIST(&AL1)&CG3
&AL1      SETA   &AL1+1
          AGOB   .A
          MEND
```

WATE (Wait)

```
*FUNCTION
*
*WAITS FOR AN EVENT TO OCCUR, THEN FLOW OF CONTROL CONTINUES.
*IF AN EVENT HAS ALREADY OCCURRED (SEE 'SET'), THEN THE FLOW OF
*CONTROL CONTINUES UNINTERUPTED
*
*
*
*MACRO DEFINITION
*
            MACRO
&LABEL      WATE     &CNTX=I,&PSG=0
            AIF      ('&CNTX' EQ 'F').A
&LABEL      LA       R5,&PSG
            AGO      .B
.A          ANOP
&LABEL      L        R5,&PSG
.B          TM       0(R5),X'80'
            BZ       GW&SYSNDX
            NI       0(R5),X'7F'
            B        GW&SYSNDX+2
GW&SYSNDX   SVC      WAIT
            MEND
*
```

REFERENCES

1. Groner, G. F., "Real-Time Recognition of Handprinted Text," *AFIPS Conference Proceedings* (1966 FJCC), Vol. 29, Spartan Books, Inc., Baltimore, Maryland, 1966, pp. 591-601. (Also, The RAND Corporation, RM-5016-ARPA, October 1966.)

2. Ellis, T. O., and W. L. Sibley, *On the Problem of Directness in Computer Graphics*, The RAND Corporation, P-3697, March 1968.

3. Brown, G. D., and C. H. Bush, *The Integrated Graphics System for the IBM 2250*, The RAND Corporation, RM-5531-ARPA (in process).

4. Davis, M. R., and T. O. Ellis, "The RAND Tablet: A Man-Machine Graphical Communication Device," *AFIPS Conference Proceedings* (1964 FJCC), Vol. 26, Part 1, Spartan Books, Inc., Baltimore, Maryland, 1964, pp. 325-331. (Also, The RAND Corporation, RM-4122-ARPA, August 1964.)